

Vol. 2. (NEW SERIES.) JANUARY, 1902.

No. 1.

BULLETIN

OF THE

WISCONSIN NATURAL HISTORY SOCIETY

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MILWAUKEE, WISCONSIN.

EVENING WISCONSIN CO., PRINTERS, MILWAUKEE.

The Wisconsin Natural History Society,

MILWAUKEE, WIS.

ORGANIZED MAY 6, 1857.

OFFICERS.

EDGAR E. TELLER—PRESIDENT.....3303 Cedar Street, Milwaukee
DR. S. GRAENICHER—VICE PRESIDENT.....551 Seventh Street, Milwaukee
W. J. BENNETTS—GENERAL SEC'Y....413 Twenty-third Street, Milwaukee
LEE R. WHITNEY—COR. SEC'Y.....Room 225, P. O. Bldg., Milwaukee
GEO. A. WEST—TREASURER.....2828 Highland Bl'vd, Milwaukee
A. BIRSACH—LIBRARIAN.....Public Museum, Milwaukee



DIRECTORS OF SECTIONS.

Secretary of Sections, C. E. Brown	Geology, - - - - C. E. Monroe
Archeology, - W. H. Ellsworth	Ornithology, - - Edw. E. Voss
Numismatics, - W. F. Sandrock	Entomology, - - C. E. Brown
Botany, - - - - E. Bruncken	Mineralogy, - - - Louis Lotz

REGULAR MEETINGS.

- (1) These are all held in the Society's lecture room in the Museum-Library Bldg., Milwaukee.
- (2) Meetings of the combined sections take place on the 2nd Thursday of each Month, at 8 P. M.
- (3) The Archeology and Numismatics sections meet on the 3d Thursday of each Month.
- (4) General meetings are on the last Thursday of each Month except July and August.
- (5) Meetings of the Archeologists and collectors of the State are to be held semi-annually under the direction of the Archeology section, for the purpose of furthering the cause of Wisconsin Archeology.

PUBLICATIONS.

- (1) The "Bulletin of the Wisconsin Natural History Society"—a 64 page octavo publication issued quarterly. Editor, W. J. Bennetts.
- (2) The "Wisconsin Archeologist," published by the Archeology section. Editor, C. E. Brown.

MEMBERSHIP DUES.

Local Members, \$3.00 per annum; Non-resident Members, \$1.00 per annum;
Life Members, one payment of fifty dollars.



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BULLETIN

OF THE

WISCONSIN NATURAL HISTORY SOCIETY.

Vol. 2, New Series.

JANUARY, 1902.

No. 1.

Proceedings of the Wisconsin Natural History Society.

September 27, 1900 to October 31, 1901.

THURSDAY, Sept. 27, 1900.

Twenty-four persons were present at this meeting, which was held in the lecture room of the Public Museum. President Teller occupied the chair.

Chas. E. Brown as secretary of sections read an interesting report on the work done at the union section meetings during the three preceding months, and concluded by dwelling at some length upon the benefits to be derived from attending these meetings.

Dr. Peckham then drew attention to a card index of publications on the flora and fauna of Wisconsin that he was then at work upon and promised to describe it at greater length at a future meeting.

The resignation of Paul H. Dernehl as librarian was accepted and Mr. Paul Rhode elected to the vacancy.

John H. Fiebing and Adolph Biersach were elected members of the society and Prof. Wm. H. Wheeler of the University of Texas an honorary member.

John A. Brandon then read a paper on local ornithology that revealed a deep interest in, and much patient observation of the birds. All of the common visiting and migratory species were considered in the order of their appearance and departure, and the habits of many of them—particularly of the horned lark, the sap-sucker and the purple martin—were described at considerable length.

A paper written by Paul H. Dernehl on the Purple Martin (*Progne subis Bd.*) was read by Chas. E. Brown. For many years past martins have each year occupied bird houses set out for their use at the home of Mr. Dernehl, and his paper was chiefly based upon notes he has taken during the past six years upon their breeding and other habits.

The meeting was then adjourned.

THURSDAY, Oct. 25, 1900.

This meeting was held in the Museum lecture room with President Teller in the chair and thirty persons present.

Chas. E. Brown reported on a meeting of the united sections of the society held Oct. 11, and also on a meeting of the Archeology Section at the home of Mr. Henry R. Denison.

Mr. F. M. Benedict then addressed the meeting on the "Earthworks and Other Traces of Pre-historic Man Existing in Wau-paca County, Wis."

After describing the topography and geological character of the region, with its underlying formations of granite and Potsdam sand, the speaker described the principal ancient village-sites, Indian trails and groups of mounds of the "Chain o' Lakes" district with which he was most familiar. The village sites were marked by numerous kitchen-middens from which little had been obtained except broken pottery and broken cobblestones, the latter bearing evidence of having once been employed when heated to boil water for the ancient villagers.

The speaker estimated the ancient cornfields to be fully 350 years old, basing his views upon the remains of trees that rested upon the ancient cornhills.

The principal mounds in that region were stated to be, (1) six effigy mounds of the turtle form that had contained encysted skeletons in a sitting posture, (2) a man mound 400 feet long, (3) a group of seven oblong mounds and (4) about 46 round mounds scattered throughout the district under consideration.

Two prehistoric excavations in the vicinity of the lakes were also described.

Dr. Stanhope, Rev. O. G. McNeill and C. E. Brown took part in a discussion that followed this address.

The following were nominated for membership by Mr. Nehrling and President Teller, and duly elected: Messrs. Carl Bartelt, Aug. Cloos, Henry R. Denison, Sydney R. Hartwell, Edw. E. Voss and Lindsay Webb.

There being no further business, the meeting was adjourned.

THURSDAY, NOV. 22, 1900.

The general meeting for November was held on the evening of the twenty-second, in the Museum lecture room, with President Teller in the chair and thirty persons present.

Chas. E. Brown reported on a meeting of the combined sections held on the eighth of the month.

Dr. Robinson was proposed for membership by Mr. Nehrling and elected a member of the society.

Dr. S. Graenicher next read a paper on the "Fertilization of *Symphoricarpos* and *Lonicera*," illustrating it by drawings showing the structure of the flowers and by specimens of all the insects he had found visiting them. Two species of *Symphoricarpos* were considered, *S. racemosus* and *S. occidentalis*. The first was visited principally by the smaller bees and the other also by a great many wasps.

Of the five species of *Lonicera* native to this locality, two, *L. ciliata* and *L. Tatarica*, are visited principally by the smaller bees, while the three remaining species, *L. dioica*, *L. oblongifolia* and *L. Sullivantii*, are bumble-bee flowers, but include also many of the smaller bees, a few flies and lepidoptera, as well as the humming bird among their visitors.

THURSDAY, DEC. 27, 1900.

This meeting was held in the usual place—the Museum lecture room—and was presided over by President Teller. The attendance was twenty-five.

C. E. Brown reported on a union section meeting and also on a meeting of the Archeology Section held earlier in the month.

Mr. Valentine Fernekes was proposed for membership by Mr. Nehrling and duly elected.

Ernest Bruncken then addressed the meeting on the physiography of Milwaukee County.

The speaker described the general features of the surface geology of the vicinity and drew attention to many problems that still awaited solution, such for instance as whether the terraces along the Menominee valley were identical in height with corresponding ones along the lake front. He drew attention also to the absence of large limestone boulders in this vicinity in contrast to their frequent occurrence farther west.

President Teller then read an instructive paper on fossil cephalopods, illustrating it with a number of specimens of local species from his own collection. He drew attention to a variation he had detected in the siphuncle of a cephalopod, *Orthoceras abnorme*

Hall, occurring in the Niagara formation at Racine, Wis., which perhaps justified its being considered as a new species or subspecies.

W. J. Bennetts read a paper on the winter birds of Lake Michigan, mentioning those species of the loons, grebes and gulls that were known to winter on the lake, and giving some attention to their winter habits.

The meeting was then adjourned.

THURSDAY, January 31, 1901.

The Wisconsin Natural History Society met this day in the lecture room of the Public Museum; thirty-three persons were present and President Teller occupied the chair.

Chas. E. Brown reported on section meetings held during the month, after which Mr. P. V. Lawson addressed the meeting on the antiquities occurring in the vicinity of Menasha, Wis.

The oldest relics of pre-historic man in that locality were considered by the speaker to be a class of chipped stone implements found by him on the shores of Lake Winnebago and at Green Bay.

They are of a black sandstone similar to the stone implements found in the Trenton gravels of New Jersey and probably belong to an age equally remote.

Next in order of antiquity are probably the stone cairns, and shell mounds, that occur at several places around lakes Winnebago and Winneconne.

Effigy mounds and oval mounds are exceedingly common in the locality considered. Three lizard mounds and a turtle mound have been preserved in the Elisha D. Smith Park, Menasha. Near Little Butte des Morts are two remarkable serpent mounds 1,210 and 1,580 feet long respectively, while near Stockbridge is what is probably the finest group of existing mounds in the world occupying 90 acres of primeval forest and representing many types.

The address was illustrated by numerous drawings and maps made from surveys taken by the lecturer, as well as by many archeological specimens and photographs.

Mr. John H. Tweedy was elected a member of the society and Dr. R. Menger, San Antonio, Texas, a corresponding member, after which the meeting was adjourned.

THURSDAY, February 28, 1901.

The Wisconsin Natural History Society held its general meeting this day in the Museum lecture room with the President in the chair and twenty-eight members and visitors present.

The report of the January meeting was read by the secretary and reports of two section meetings by Chas. E. Brown. At one of these—a meeting of the Archeology Section on the 21st—it had been proposed to extend the membership of the section so as to include archeologists from all parts of Wisconsin, and thus give the section the character of a state organization.

As a preliminary step in this direction Chas. E. Monroe gave notice that at the next meeting he would propose a change in the by-laws of the society so that hereafter the fee of non-resident members should be one dollar a year.

Mr. A. W. Slocum then read an instructive and interesting paper entitled, "The Development of Life Upon the Earth as Revealed by Paleontology."

After a brief historical account of the growth of the science, the different forms of fossils were mentioned and described, as well as illustrated by specimens and plaster of Paris models.

The geological eras were then considered in their order and at this point Mr. Slocum displayed a set of charts prepared by himself to illustrate the development of each of the classes of the animal and the vegetable kingdoms during geologic time. Each class was then taken up separately and its development clearly described, numerous specimens from the Public Museum collection of fossils being employed to illustrate the subject.

At this meeting Mr. Otto Grigrutsch was elected an ordinary member of the society.

THURSDAY, March 28, 1901.

President Teller presided over this meeting, at which twenty-eight persons were present. The minutes of the last meeting were read by the Secretary and Mr. C. E. Brown reported on two section meetings of much interest that had been held earlier in the month.

The lecture of the evening was to have been one on paleontology by Dr. Stuart Weller of Chicago, but the day previous word had been received from him that he would not be able to be present.

Three members of our society had therefore hastily prepared papers for the evening, which, if somewhat incomplete, were yet interesting on account of the variety of subjects treated.

The first paper by C. E. Brown was on the "Geographical Distribution of the Milwaukee Butterfly, *Anosia pleippus*." The development and habits of this commonest of our lepidoptera were described and its range on the American continent shown to be from the shores of Alaska and Hudson Bay to the northern boundaries of Patagonia.

During the last half century it had spread westward to the South Sea Islands, the Malay Archipelago, and the Southern Asiatic coast, while to the east of our continent it had during the same period obtained a foothold in the Bermudas, the Azores and the western countries of Europe and Africa. At the end of another half century Mr. Brown predicted it would be doubtless common throughout most parts of the known world.

Mr. W. J. Bennetts then read some notes on the life history of the Virginia deer, *Cariacus Virginiana*.

The points chiefly considered were the development of its different coats and of the antlers, and its food and feeding habits at different seasons of the year.

Geo. A. West followed with a paper based upon a recent journey taken by him through the Republic of Nicaragua, Central America.

It dealt principally with the habits and superstitions of the natives of the East Coast. He also described at some length the peculiar habits of the leaf-carrying ants and also of the termites or white ants, to both of which he had paid considerable attention while in their habitat. Mr. West also exhibited a sheet used by the Indians and made from the inner bark of a native tree, and also some artistic examples of inlaid gold work done by one of the native women.

The meeting was then adjourned.

THURSDAY, April 25, 1901.

This being also the annual meeting of the society, much of the time was occupied by the reading of the reports of progress by the different officers.

C. E. Brown described what had been accomplished in the Biology sections and in the sections of Archeology and Numismatics during the past year, while the report of the treasurer, J. A. Brandon, showed that financially the society was in a satisfactory condition, there being a balance of \$232.77 in the treasury. W. J. Bennetts also reported concerning his work as recording secretary and editor of the society's Bulletin.

Secretary's Annual Report for the Year from April 27, 1900, to April 25, 1901.

The progress made by the society during the past year and the work accomplished by it has been of a satisfactory nature.

Its membership now numbers 109, an increase of 22 over that of last year. Ten general meetings have been held, at which the average attendance was 27 and at which 15 papers were read

by members of our society and others. These papers were principally of a popular nature, being intended for the general membership of the society and not for the specialist, and were as follows:

1. "Dakota Burial Mounds".....Lee R. Whitney
2. "Forestry".....Ernest Bruncken
3. "Crustaceans of the Niagara Formation".....E. E. Teller
4. "Sand Dunes at Ottawa Beach".....E. Bruncken
5. "Local Ornithology".....J. A. Brandon
6. "Earthworks of Waupaca County".....F. M. Benedict
7. "Fertilization of Lonicera and Symphoricarpos".....
.....Dr. S. Graenicher
8. "Physiography of Milwaukee County".....E. Bruncken
9. "Fossil Cephalopods".....E. E. Teller
10. "Winter Birds of Lake Michigan".....W. J. Bennetts
11. "Antiquities of Menasha".....P. V. Lawson
12. "Development of Life Upon the Earth as Revealed by
Paleontology".....A. W. Slocum
13. "Life History of the Virginia Deer".....W. J. Bennetts
14. "Indian Tribes of Nicaragua".....G. A. West
15. "Geographical Distribution of Anosia Plexippus".C. E. Brown

One of the most important ways in which our society has been of use to its members has been through the interchange of ideas and observations at the section meetings.

Of these 19 have been held, 9 of the Archeology section, and 10 union meetings of the other sections. Many papers of a special character and containing the results of original investigation were presented at these meetings, a detailed account of which will be found in the report of their proceedings.

Two Bulletins, aggregating 130 pages, have been issued during the year. It has been our aim to publish nothing in our periodical but articles containing a large proportion of new facts or based upon original observations and research.

Naturally our society is expected to be the authority on all matters relating to the natural history of its own locality and to make it its special object to encourage and to carry on investigations in that field.

In this regard the work done has been encouraging and satisfactory. In the field of entomology we have published a list of the Lepidoptera of Milwaukee County by Messrs. Rauterberg and Dernehl, a list of the Syrphidae by Dr. Graenicher, and studies on our solitary wasps by Geo. W. and Eliz. G. Peckham.

In the field of Botany Dr. S. Graenicher has worked up the local methods of fertilization of a great many of our native plants and we have published his papers on the fertilization and insect

visitors of the different species of *Lonicera* and *Symphoricarpos*, and on *Trillium nivale*, *Erigenia bulbosa* and *Salix discolor*. Ernest Bruncken has also reported on the forest conditions of the vicinity and has worked up our species of *Salix* and *Betula*, while W. J. Bennetts has published a second supplement to W. M. Wheeler's "Flora of Milwaukee County."

In Ornithology we have published papers on our local Avifauna by John A. Brandon, P. H. Dernehl and W. J. Bennetts.

A paper by Geo. A. West on the "American Crocodile" was a valuable contribution to our knowledge of that little known animal.

Still, an enormous amount of work remains to be done in developing the knowledge of our local natural history. Wisconsin is almost an unworked field in this respect and less has been done in the way of exploring its flora and fauna than has been accomplished in much younger states lying to the west of us. Even in regard to the district lying immediately around our city it may be said that definite and accurate knowledge is still wanting in almost every line of natural history. The following subjects only may be mentioned regarding each of which almost no work has been done,—the mosses, lichens, fungi, fresh water algæ, the fishes, batrachians, crustaceans, reptiles and molluscs, without entering at all the immense field of entomology.

A recently published bibliography of Indiana molluscs contains twelve pages and about 100 titles. A Wisconsin list would probably contain the titles of less than a dozen papers.

There are two matters which affect us in accomplishing work of this kind and which should receive careful consideration by our society in the near future. There should in the first place be a closer working relationship between our society and the Milwaukee Public Museum.

In order to arrive at an accurate knowledge of any of our local species it is necessary that large numbers of specimens be collected and preserved for future comparison and study. As an example it is well known that our common garter snake, *Eutaenia sirtaris*, is exceedingly variable, so that eleven or more sub-species are distinguished, and it is plainly only possible to arrive at the status of our own local species and varieties by the accumulation of a large collection of specimens. Some understanding and method of co-operation should clearly exist between our society and the Museum in matters of this kind.

Another matter. When our society was first organized one of its leading objects was clearly stated to be the formation of an efficient reference library of natural history works. For the past 40 years it has been receiving books and pamphlets of this char-

acter by purchase and exchange, and these are all at present stored in the offices of the Public Museum, and, besides being almost inaccessible, are uncatalogued and unindexed, and therefore of practically no use to the society.

There is urgent need for a well arranged and fairly complete Natural Science Library here in Milwaukee, and we should not let the matter rest until something permanent has been accomplished in this direction.

Still another matter has been in a manner thrust upon us during the past few months. The founders of our society plainly intended it as a state organization, and named it the *Wisconsin* Society, and distant parts of the State have at all times been represented on its membership roll, but the actual work of the society has practically always been confined to the vicinity of this City and to Milwaukee County.

Letters, however, have been received of late from science teachers, collectors and archeologists throughout the state, expressing a desire that our field of work be extended so that our society become in fact as in name a state organization. In fact steps have already been taken in our Archeology Section to extend its membership and its field of work in this way, but we think it wise to consider the matter well and weigh well all our resources before committing ourselves to any definite step of this kind. A large non-resident membership can only be successfully retained and the work of the organization carried on with such, by correspondence and publications, and this implies an immense amount of work for those who have it in charge. In other societies where such work is successfully conducted, those entrusted with it are generally persons having considerable leisure or those holding positions whose duties do not clash with the work they do for their society, such as government scientific officials or University professors.

There are, we believe, no men of leisure among our active members and probably none who could look after such work efficiently without considerable self-sacrifice, so that it behooves us not to hastily take any step in this matter until we are assured that what we do will be permanent and done well.

W. J. BENNETTS, *Secretary*.

A Committee on Membership, consisting of Messrs. Habhager, Cline, Stanhope and Bennetts, which had been nominated at a section meeting, was approved by the society upon a motion made by Mr. Harlowe.

A motion to the effect that the dues of non-resident members should henceforth be \$1.00 per annum was made by Dr. Chas. Stanhope and unanimously carried.

The officers for the ensuing year were then elected as follows:

President—E. E. Teller.

Vice-President—Dr. S. Graenicher.

General Secretary—W. J. Bennetts.

Corresponding Secretary—Lee R. Whitney.

Treasurer—Geo. A. West.

Librarian—Adolf Biersach.

DIRECTORS OF SECTIONS.

Entomology—C. E. Brown.

Botany—E. Bruncken.

Archeology—W. H. Ellsworth.

Numismatics—W. F. Sandrock.

Geology—C. E. Monroe.

Ornithology—

Mineralogy—Louis Lotz.

The following were also elected to membership: Messrs. A. S. Mitchell, J. A. Sheridan, Thos. G. Laurenzen.

Mr. Adolf Biersach then read a paper entitled, "Snakes of the Genera *Elaps* and *Osceola*." *Elaps* is a genus of poisonous snakes consisting of about thirty species, whose character as to whether they are poisonous or non-poisonous was for many years a subject of debate among herpetologists. They are beautifully marked with red, black and yellow rings, and are mimicked in this particular by the king snakes of the genus *Osceola*, which on the contrary are all perfectly harmless.

It was shown by the speaker that the venomous genus could be distinguished from the non-venomous one by the fact that in *Elaps* the black rings are bordered by the yellow, while in *Osceola* the yellow rings are bordered by black.

The paper was illustrated by charts and drawings and by alcoholic specimens of *Elaps fulvius* and of *Osceola doliata coccinea*.

THURSDAY, May 30, 1901.

At this meeting Mr. A. Schroeder and Rev. J. W. Berg of St. Francis were elected members of the society, after which those present listened with much interest to a lecture by Prof. Stuart Weller of the University of Chicago entitled, "Modern Problems in Paleontology."

The lecturer described the methods employed, and some of the results achieved, by that branch of Paleontological Geology which dealt with faunal societies. It was shown how by its aid it was possible in a measure to restore the ancient geography of the earth at any geological period, and to determine the migrations of any of the fossil faunal types.

Prof. Weller then considered the Mississippi valley region of our continent; treating in detail each geologic period from the Silurian, up to and through the Carboniferous, showing how it was possible by a comparison of the fossil fauna of each era to map out the shallow seas and the land barriers then existing, and also to determine the order in which the changes took place, and from whence new fossil types were derived.

THURSDAY, June 27, 1901.

The general meeting of the Wisconsin Natural History Society for June was held in the usual place—the Museum lecture room—President Teller occupying the chair.

C. E. Brown read reports of section meetings held during the month, and he also stated that the botanists of the society had recently added many new plants and species of fungi to the Museum collections. Mr. William Riley was elected a member of the society. The election of Mr. Edw. E. Voss as director of the section of ornithology was approved. The attendance was 24.

Chas. E. Brown then read a paper entitled, "Types and Distribution of Grooved Stone Axes." It was shown how, according to the peculiarities of the handle-groove, they could be arranged into three main divisions: (1) Those having only a notch in each opposite side of the axe; (2) those with a groove extending around three sides; (3) those in which the groove completely encircled it. These could again be divided into several sub-classes according to the position and number of the grooves or the general shape or ornamentation of the axes themselves. Drawings were exhibited of specimens belonging to each class and the material, possible uses, and occurrence of these axes throughout the state discussed.

This paper was followed by a lecture by E. Bruncken on "Ecology," in which the general principles of this recently developed branch of botany were stated and explained, and applied to many of our local species of plants.

Mr. Herman Pereles of the Numismatic section then read an instructive paper entitled, "Jackson Tokens and Hard Times Money." He described the financial and political conditions that led to the issuing of these interesting series of coins, as well as many of the coins themselves in detail.

Dr. S. Graenicher next read a paper entitled, "Flowers Adapted to Carrion-Fly Visitors," which dealt principally with the fertilization of our three local species of *Smilax*, *S. herbacea*, *S. hispida* and *S. ecirrhata*, specimens of which and of their insect visitors were exhibited by the speaker.

A valuable collection of coins belonging to Mr. Altenberg was examined with much interest by those present. The expenditure connected with the holding of a State Archeological meeting was authorized by the society, after which the meeting was adjourned.

THURSDAY, SEPTEMBER 26, 1901.

At this meeting, which was attended by 26 persons, President Teller brought the matter of the society's library to the attention of those present, stating that the documents relating to the transfer of the books to the Public Museum had been lost, and that while the Trustees of that institution had expressed their willingness to have the library properly catalogued and put in charge of a competent person, they did not see their way clear to do so while the ownership of the books remained in doubt.

The subject was discussed at some length by E. Bruncken, Dr. Stanhope and Chas. Doerflinger, after which a committee consisting of Messrs. Peckham, Monroe, West and Bennetts was appointed by the President to confer with the Museum Board and to look after the society's interest in this matter.

C. E. Brown then briefly reported concerning the section meetings that had been held since the last general meeting of June 27, after which the first paper of the evening was read by Chas. Doerflinger, whose subject was "The Prehistoric Exhibit at the Paris Exposition of 1900." He described especially the excellent reproductions of the rock pictures from the walls of caves that had recently been discovered in Southern France, those of the cave "Pair-non-Pair," near Bourg sur Gironde, being of unusual interest; and also drew attention to the value added to the exhibits by the numerous books of reference that accompanied them and that were accessible to all visitors. The adoption of some similar plan by our Public Museum was suggested in the paper.

Adolf Biersach followed with a paper on the habits of the common toad, which consisted largely in a defence of this useful little animal against the evil reputation that the superstition and ignorance of the people had conferred upon it.

At this meeting twenty persons were elected to membership as follows: E. R. Buckley, of Rolla, Missouri; Horace Peck, Sr., of Prairie du Chien; F. M. Caldwell, Princeton; W. P. Clark, of Milton; Matt Duane, Marshall; Wm. Finger, Milwaukee; Frank B. Fargo, Lake Mills; P. D. Griste, East Troy; Alphonse Gerend, St. Francis; W. W. Gilman, Boscobel; H. M. Jaycox, Lake Mills; Rudolf Kuelme, Sheboygan; Rev. J. G. Laurer, Plain; I. H. Lyman, Kenosha; Frank Mueller, Princeton; G. F. Melcher, Woodland; R. L. Porter, Mukwonago; Chas. Slocum,

M. D., Defiance, Ohio; Geo. Schuette, Manitowoc; C. E. Wood, Mukwonago; H. A. Willard, Mazomanie.

Dr. Harlan J. Smith of the American Museum of Natural History was elected an honorary member.

THURSDAY, October 31, 1901.

The attendance was twenty-nine at this meeting, which was presided over by President Teller.

Chas. E. Brown, the secretary of sections, read the proceedings of a meeting of the Biology section and also of a meeting of the Archeology section, both of which had been held during the past month.

He also reported as to the work accomplished during two excursions made into Waukesha County on Sept. 30 and Oct. 21. Ten groups of undescribed mounds and several isolated mounds and earthworks had been surveyed and platted and considerable data collected in regard to the copper and stone implements peculiar to the localities.

The following were elected to membership: Miss H. B. Merrill and Messrs. S. C. Wadmond of Racine; Dr. H. B. Hinsdale of Ann Arbor, Mich.; P. V. Lawson of Menasha, S. D. Mitchell of Ripon, W. H. Canfield of Baraboo, Louis Falge of Reedsville and Herb. J. Johnson, O. L. Hollister and W. H. Vogel of Milwaukee.

The committee appointed to look into the matter of transferring the society's library to the Public Museum then reported through its Chairman, Dr. G. W. Peckham, as follows:

"Your committee to whom was referred the question of relations between the Natural History Society and the Public Museum, have the honor to report as follows:

First. They believe that in the interests of all concerned the library should be catalogued.

Second. That exchanges should be maintained and that where breaks occur in the series, steps should be taken to make good the missing volumes.

Third. That during certain days of each week the library should be open during reasonable hours during the evening. Under the present conditions the library is inaccessible except to persons so fortunate as to be able to command their own time.

Your committee further believe that if proper arrangements can be made with the Museum Trustees, that there can be no objection to the transfer of the title to the Museum. As an alternative proposition, and in the event of the Museum not caring to undertake any responsibility in caring for the library, the com-

mittee suggest that it be transferred to the Public Library of the city, where it would be catalogued and accessible to the public.

Respectfully submitted,

G. W. PECKHAM,
C. E. MONROE,
G. A. WEST,
E. E. TELLER,
W. J. BENNETTS.

Ernest Bruncken then moved that the committee be given full power to make an agreement with the Museum or the Library on the basis of these principles, which motion was seconded and carried.

The lecture of the evening was by Dr. Peckham and was entitled "Some Points in Geographical Distribution."

The speaker illustrated by numerous examples the fact the world could be divided into many life or faunal areas, and that the original explanations given of these, such as, for example, that they depended upon the amount of heat, or that certain resemblances were due to a former land connection, failed to interpret the facts as they were now known. The modern view is that distribution was brought about by the same natural forces that are to-day in operation, and that those changes that are at work in Geology operate also in Biology.

The West India Islands have a warm and tropical climate, but are remarkably destitute of animal life, both of species and individuals, except in the case of introduced species. Geology shows that they have been several times raised and submerged and as many times has life been destroyed and repopulation taken place, doubtless by drift species from the nearest mainland.

This theory is supported by the fact that the fauna of Cuba is related to that of North America, while that of Jamaica resembles more nearly that of South America.

Prof. E. C. Case, after the lecture, discussed these latter points, showing that any extensive migration from the adjacent continent would be largely prevented by the prevailing winds and currents from the eastward, and that in the case of amphibia it would be prevented by the fact that salt is fatal to most of the species.

Mr. W. H. Ellsworth displayed a grooved stone axe from Dakota which was of unusual shape, being almost entirely spherical.

The meeting was then adjourned.

WM. J. BENNETTS, Recording Secretary.

Studies in Plant Distribution.

By ERNEST BRUNCKEN.

1. On the Succession of Forest Types in the Vicinity of Milwaukee.

In a former paper (Bull. Wis. Nat. History Society, I, page 178) the forest conditions in the vicinity of Milwaukee were considered principally from the economic standpoint. The following pages are an attempt to treat some of the peculiarities of the forests of the same region from the standpoint of ecological distribution.

The forests of the Milwaukee region are almost exclusively of the deciduous, mesophytic type, xerophilous associations being now represented only by the meager remnants of tamarack swamps still lingering here and there. But there is evidence of the former prevalence of xerophytic, principally coniferous associations; and within the mesophytic association a number of distinct groups of more or less pronounced mesophily can be clearly distinguished. Between these sub-associations a vigorous contest is carried on, so that there are numerous transition stages.

The mesophytic association may be conveniently divided into three sub-associations, according to the degree of mesophily exhibited in the species of which they are most prevalently composed. These sub-associations are:

1. The hemi-xerophytic sub-association. Its characteristic species are various oaks, particularly the white and burr oaks; the shell-bark hickory and the black cherry.

2. The mesophytic sub-association, with the basswood, the hard maple, and in a part of the region the beech (1) as its most characteristic members.

3. The hemi-hydrophytic sub-association, in which various elms, black ash and cotton wood are leading species.

The first of these sub-associations is probably the most widely spread in the region. It is characterized by the great light demand of the trees composing it. In addition to the species mentioned, we find in this sub-association *Quercus rubra* and *tinctoria*, *Ostrya Virginica*, *Populus tremuloides* and *grandidentata*, *Hicoria ovata* and *glabra*. The underbrush shows, in addition to the young seedlings and saplings of the trees, several shrubs with xerophytic characters, such as various species of *Ribes*, haz-

(1) On the peculiarities of distribution of the beech, see Wis. N. H. S. Bulletin, I, page 33.

elm and witch hazel. In places there are thickets of *Rubus*, and *Xanthoxylum* is not uncommon. The herbaceous flora is rich, both in species and individuals, and golden rod, sunflower and asters find here their favorite habitat.

The second sub-association is characterized by the great shade tolerance of some of its members, and probably as a consequence of the deep shade prevailing in its midst, by the thick layer of humus found on the floor. In addition to the hard maple and basswood, there belong to this association the butternut, the black walnut (now rare), and the white ash. The underbrush is apt to be less dense than the preceding class, and often confined to the places where the canopy has been broken. It is composed largely of the same shrubs that are found in the preceding sub-association, except that the hazelnut is not likely to be found, and that *Sambucus nigra* may be added. The herbaceous vegetation is apt to be scanty, especially in summer, when the crowns are fully leaved. Often the dry leaves monopolize the floor almost entirely. Among the herbs most often accompanying this association should be mentioned *Podophyllum peltatum*, *Viola scabriuscula*, *Trillium grandiflorum*, and two species of *Erythronium*.

This sub-association rarely occupies large areas; it is usually found in the form of islands among the surrounding sea of the hemi-xerophytes. Often it inhabits damp ravines, where the accumulation of humus is assisted by washing from the sides. As the two associations are still in the fighting stage, neither is very firmly established in any particular locality. Consequently it is by no means uncommon to find individuals belonging to the one sub-association scattered among the other. But in those places where there has been no modification by human interference such as will be described below, this difference is quite noticeable: The hemi-xerophytic trees scattered among the maple-basswood sub-association are usually old, often veterans in a state of evident decay; on the other hand, where maples, basswood and their associates are found among the oaks and hickories, they are more often young trees. This phenomenon will throw considerable light on the history of these forests, and should be borne in mind for the discussion which will follow below.

The hemi-hydrophytic sub-association may again be divided into a double group, according as it is found in the swampy depressions of the uplands or in the river bottoms. The difference is not so much in the species as in the way in which they are associated. In the upland swamps (2) *Ulmus Americana* and *Frax-*

(2) These swamps are usually fairly well drained, dry after about the first of July, and very distinct from the tamarack swamps. Their center is usually in part open water, in part occupied by the swamp loving shrubs mentioned in the text.

inus nigra are by far the most numerous, silver and red maple (3) are interspersed very sparingly, *Ulmus fulva* a little more frequently, and *Quercus bicolor* is common. The underbrush consists of many species of *Salix*, *Cornus*, *Viburnum*, etc. Creepers, such as *Ampelopsis*, *Lonicera*, *Smilax* are characteristic of this as well as the second group of this sub-association, while they are practically unknown in the other forest associations (with the exception of *Evonymus*). The soil is probably sour in not a few cases, as would be indicated by the rich development of swamp-loving mosses, *Cyperaceae*, etc. Phanerogamic herbs growing under the shade of the trees mostly have some xerophytic characters (*Viola blanda* and *Labradorica*, *Majanthemum Canadense*, etc.), in sharp contrast to the hydrophytic flora towards the middle of the swamps.

The second group of the hemi-hydrophytic sub-association, the bottom woods, has been more disastrously affected by human activity than any other portion of the forests of the region, except the tamarack association. There can be little doubt that previous to the settlement of the country this group occupied the entire valleys of the Milwaukee, Menomonee and Kinnickinnic Rivers with the exception of the sedge and wild rice marshes at their mouth, and perhaps isolated patches of tamarack swamp and hydrophytic shrubbery. To-day a few small remnants is all that is left of the bottom forest, such as the grove near the junction of Honey Creek and the Menomonee. On the pastures which now form the largest part of the river valleys, there are scattered a good many groups and individual trees, some of them in full vigor, others in various stages of decay, stag-headed and hollow-boled. From these remnants, however, it is possible to draw a mental picture of what these woods must have looked like when they were in their pristine glory. Three species of elm (*Ulmus Americana*, *fulva* and *racemosa*) seem to have furnished the most numerous host; associated with them were *Celtis occidentalis*, which now remains only in comparatively few individuals, the largest group known to the writer growing near the County Insane Asylum, *Quercus bicolor*, *Acer dasycarpum*, *Acer Negundo*, *Populus deltoides*, *Fraxinus nigra*, *Salix amygdaloides*. The trees in this group seem to have grown to very great dimensions, if one may judge from the giants which still remain. Creepers of the species mentioned above were abundant. It is probable that the forest was interrupted by considerable areas covered with shrubs. Such thickets have again come up in many places since the original growth was destroyed.

(3) Young red maple trees are occasionally found among young growths of hard maple, away from the proximity of swamps.

They cannot properly be classed with forest associations, but must be considered as a distinct formation, and will not be considered here in detail. The remnants of the bottom wood group are in evident course of extinction. The old trees are gradually dying or being removed by the axe. Windfalls are exceedingly common in the thinned stands of elm. The young trees that are coming up are as apt to be hard maples and other trees from the mesophytic uplands as the progeny of the original occupants.

Having thus briefly described the three mesophytic forest sub-associations of the region, the question arises as to their history. The hemi-hydrophytic sub-association is evidently conditioned directly by the physiography of the country. But the other two seem to be far more directly the result of the struggle for life among species.

To understand the mutual relations of these two types of forest it is necessary to throw a glance at a somewhat wider region than that under immediate consideration. The vegetation map of Eastern Wisconsin, accompanying the first Geological Survey of the State, shows that there is a broad belt to the west of Milwaukee County, which is there denominated the Oak Group. To the east of this is a strip classified as the Oak and Maple Group, and still farther east comes the Maple and Beech Group. A visit to the forest anywhere within the Oak Group will show that various species of oak are almost the only trees found there. Their only associates are the hickories, only in some places the black cherry is found. These are precisely the species which have been mentioned as the characteristic ones of the hemi-xerophytic sub-association. Perhaps it is possible to divide even this sub-association into several groups of more or less highly developed xerophily. At all events, the white and burr oak seem to have more pronounced xerophytic characters than the red and black oaks, and it is well known that groves of stunted burr oaks are not uncommon as far West as South Dakota, where conditions are decidedly xerophytic.

A closer study of the oak forests will show that here and there, usually in a deep ravine or in the neighborhood of a lake or water course, there are a few individuals of basswood. The vicinity of such trees is usually distinguished also by the occurrence of strongly mesophytic herbs, such as *Podophyllum peltatum*, which are uncommon in the purely oak forests. Sometimes one will notice that the basswood and its minor companions grow exclusively on the southerly side of a ravine, while they are entirely absent on the northerly side. One remembers that these locations receive less sunlight than the northerly slopes. Their greater shade and consequently damp and cool condition retards the oxydization of

the vegetable mould, and in such places the humus is deeper and richer than is usual in the oak woods, with their insufficient shade. As one travels eastward, the maple makes its appearance, at first sparingly and confined to such localities as have just been described. By the time one is fairly within the territory of the Oak and Maple Group of the map, maples and basswood and their associated trees mentioned above occur with growing frequency on the ordinary uplands as well as in ravines and coves. Going still farther east, and coming within two or three miles of Lake Michigan, one begins to find the beech, the tree which of all trees of the region throws the densest shade and grows in the places with the deepest and richest humus.

This geographical arrangement suggests that its cause is the amount of humus required for the various species. The oaks and their associates demand the least of it. The basswood comes next, while maples and beeches demand the richest soil. It might be supposed that the distribution of these trees is determined by the mineralogical character of the soil on which they grow. But this is negatived by a comparison of the vegetation map and the soil map found in the Geological Survey atlas. From this it appears that maples and beeches are found indiscriminately on "heavy marly clay," "lighter marly clay," "calcareous sand" and "red clay"; while the oak forests, although mostly on "lighter marly clay," are by no means confined to that soil formation.

Although sufficient sunshine reaches the forest floor under an oak canopy to cause comparatively rapid oxydization of the vegetable mould, that process is not rapid enough to prevent the slow accumulation of humus even in an oak forest. It is consequently a mere question of time until there will be sufficient humus in all the oak woods to satisfy even the hard maple. But as soon as the maple has gained a foothold it prevents by its dense shade the growth of oak seedlings, while its own seedlings, with their remarkable shade tolerance, can flourish well enough. At the same time it gives a great impetus to the further accumulation of humus. In the course of ages, therefore, with no new factor entering into the process, the maple and its associates would supplant the oak and its accompanying species everywhere in this region. The maple-basswood-beech sub-association is consequently the culmination type of forest in this locality. It is safe to assume that at one time Milwaukee County was covered by almost pure oak forests (with the qualification to be discussed forthwith), such as are now struggling with the prairie formation in the Rock River valley and the country immediately to the east of that.

The further question presents itself: Why are the maples,

basswood and beeches so much better developed in the neighborhood of Lake Michigan than they are twenty or thirty miles inland? The hypothetical answer which suggests itself is that the nearness of so large a body of water has a modifying influence on the hygricity and temperature relations of the climate, by which the accumulation of humus in the oak forests is favored by retarding of oxydization. The correctness of this hypothesis can be determined by nothing except numerous and long-continued meteorological observations in various localities. Such data are not in existence, and there is no prospect that the gathering of them will be commenced in the near future.

The culmination type of forest has not been reached in this vicinity anywhere except in small, isolated, specially favored areas. By far the greater part of the territory is in a transition stage, presenting neither the purely mesophytic nor the hemi-xerophytic character. On the whole it is probably easier to find areas decidedly of the latter kind than of the former. It is apparent, then, that the course of development from the oak forest through the various transition stages to the basswood-maple-beech, or perhaps eventually to the pure maple forest, has not yet become completed.

Perhaps it would be more correct to say: Had not been completed when the settlement of the region brought in a new factor of the greatest modifying power. Not only was the greater part of the territory wholly deprived of its forest cover by human hands, but the remaining tracts of forest were cut up into small parcels, of sizes ranging up to about a hundred acres, but usually much smaller. This reduction alone would probably be sufficient, by allowing the better access of wind to the forest floor, to make the conditions more xerophytic, especially as the edges of the tracts are rarely protected against the drying influence of the wind by a mantle of shrubs. But in addition a great many trees have been culled from the forest everywhere, so that frequently the crown cover is very much broken and the sunshine has full access. This of course increases the rate of oxydization of the humus and prevents its accumulation to a great degree. The floor in such places is often covered with a dense growth of grasses. All these factors tend to reverse the natural progress towards the purely mesophytic sub-association. It is quite noticeable that taking the region as a whole the oaks are on the increase. In many places, especially where there is much grass, oaks are practically the only young trees to be found.

However, there are isolated tracts here and there, on which, through accident probably more often than design, the maple has

been favored. This has occurred where the culling has been moderate, so that the shade on the floor remained too dense to allow the growth of the intolerant oaks. Thus there is a considerable tract in the town of Wauwatosa, which is now an almost pure maple wood with the young trees ranging in age from the last year's seedling up to good-sized poles. The few standards remaining are in about equal numbers oaks and maples, but oak seedlings are entirely absent. The floor is almost bare of vegetation and the humus deep and rich. Similar places are found scattered in many parts of the country.

It was stated in the beginning of this article that there was evidence of this region having been clothed at one time with a xerophytic forest, mostly composed of conifers. This proposition remains to be discussed.

A glance at the vegetation map shows that to the north of Milwaukee County the Oak and Oak and Maple Groups are replaced by two quite dissimilar types of forest. In one of these the white pine is prevalent; this group stretches along the Lake Shore in a strip that gradually narrows as it comes South. The other type is characterized by the prevalence of hard maple, yellow birch and hemlock, and the almost complete absence of oak. This is the association which covers such large areas in the central part of Northern Wisconsin (4). Of both these associations relicts are not infrequently found in the neighborhood of Milwaukee, thus indicating that they must once have been represented in this region.

The white pine association has for its most characteristic companion tree the paper birch. This tree is still common in a very narrow strip along the shore of Lake Michigan. The white pine itself formerly occurred in the same narrow strip, but the last large specimens seem to have disappeared a few years ago. It is said that a few very small individuals are still growing in a ravine near Fox Point. Going south, from Milwaukee, the white pine re-occurs on sandy beaches and on the dunes near Chicago. The paper birch is very well developed in several places along the Lake Shore, to the South, conspicuously so on the broad and swampy land flat north of Waukegan, Ills. Small species usually accompanying this association, such as *Pteris aquilina*, are found sparingly in the paper birch strip, although they are entirely absent everywhere else in our territory. The conclusion can hardly be avoided that the white pine areas of the North and the Southern

(4) See Roth, Forest Conditions of Northern Wisconsin.

end of the Lake were formerly connected by a strip along the Lake Shore (5).

The signs that the maple-yellow birch-hemlock association was ever present in this neighborhood are not quite so convincing as those of the white pine association. The only direct evidence discovered so far is the occurrence of *Betula lutea* in this neighborhood (see Bull. Wis. Natural History Soc., I, page 31). But there is good theoretical ground for assuming such a stage in the history of our forest. For in the regions to the Northward, the white pine association is normally succeeded by this or similar associations, the development proceeding from the interior to the shore (6).

The white pine association is of course typically xerophytic; the only other xerophytic forests found in our region are the tamarack swamps, which were formerly quite extensive but have now almost disappeared, principally through the direct activity of man.

The result of this inquiry into the history of the forests of the Milwaukee region is the following:

The earliest forests of which we can find any trace belongs to the xerophytic white pine association. It was probably succeeded more or less completely by a forest similar to the hardwood forests of Central Northern Wisconsin, in which maples, yellow birches, and perhaps hemlock played a leading part. Whether this group ever occupied the whole area not reserved to the white pine association, or whether in some places the pines were directly supplanted by the oaks that must have invaded the territory from the Southwest, it is now impossible to tell. Nor is there any clear evidence to show what caused the birches to disappear. It is certain that the oaks successfully conquered the whole territory excepting the swamp lands and river bottoms, which developed distinct associations. What gave the oaks their temporary advantage over the maples and birches we do not know. After a while the maples, but not the birches, began to reconquer the lost ground, and the forests progressed towards a basswood-maple-beech culmination type, when the interference of man gave a renewed advantage to the oaks.

II. Contributions to the Ecology of the Genus *Viola*.

The fact that a large number of plants growing in undrained swamps have numerous xerophytic characters is well known.

(5) The immediate shore of Lake Michigan, i. e. the beach, terraces, clay banks and ravines, have so distinct and peculiar a flora that they deserve separate treatment, which must be reserved to a later time.

(6) See H. N. Whitford, Genetic Development of the Forests of Northern Michigan, Botanical Gazette, vol. 31; May, 1901.

Various suggestions have been made to explain this phenomenon, which is so surprising when first encountered (7), but hitherto these suggestions have not ripened into more than plausible hypotheses. The following observations may furnish some material towards an ultimate solution of the problem:

The genus *Viola* is represented by seven species in the near neighborhood of Milwaukee, and by at least four others in other parts of Eastern Wisconsin. These species form an illustrative series in which xerophytic characters increase as one departs from those growing in typically mesophytic places to either those species inhabiting dry hillsides or wet and boggy situations. The species forming the mesophytic center is *V. scabriuscula*. It has hardly anything suggestive of a protection against excessive transpiration, with its broad leaves, juicy stems, light green color and almost complete absence of pubescence. This species flourishes in the shadiest portions of our mesophytic forests, under the hard maples and beeches, where the humus is deepest and yet the drainage sufficient to prevent the formation of deleterious acids. Very similar to this species both in habit and habitat is *V. Canadensis*, which does not occur in Milwaukee County but is fairly common farther North. The next species in regard to slight development of xerophytic characters is *V. pubescens*. The name of this species is by no means suggestive of its general appearance, for while one can find individuals with a fairly conspicuous coat of hair, there are others almost as naked as *V. scabriuscula*. The seed pod is an exception, for this organ is invariably covered with a very close coat of hair. This species is also found principally in the mesophytic forest, but it is not so closely confined to the beech and maple groups as *scabriuscula*. It is quite satisfied with the ordinary type, where oak, hickory, cherry and other trees compete with the maple, where the shade is less dense and the humus does not reach the same thickness and richness. *Viola obliqua* and the rather rare *V. ovata* come next. They are not absent from the forests where *V. pubescens* has its favorite stations, but far more characteristic of thickets of shrubs and saplings, where there is still a reasonable amount of humus. They are also found in the vigorous grass of meadows, and in the willow brush along the rivers. In at least one place I have found *Viola obliqua* growing copiously in a small sedge marsh. Both of these species have a few xerophytic characters, the most conspicuous of which is the rolling in of the leaf edges. (This also occurs sometimes in *V. pubescens*). By this the stomata of the upper leaf surface are protected from the wind.

(7) See Warming, *Oekologische Pflanzen-Geographie*, German ed., page 69.

All the species mentioned so far one would not think of classing otherwise than as mesophytes. The next one, however, is quite distinctly xerophytic, although not extremely so. This is *V. sororia*, a species very similar to *V. obliqua*, but distinguished by the pronounced hirsuteness of the green parts. It is perhaps the commonest species in this neighborhood, and invariably occupies dry localities, such as sunny hillsides or the hawthorn scrub lands. Hardly ever does one find this and its cousin, *V. obliqua*, intermingling, although it is common to see the latter flourish at the foot of a hill, where the ground is fairly moist and the insolation moderate, while the adjacent slope, dry and exposed to hot sunlight, shows numerous plants of *V. sororia*. Stations similar to those occupied by this species are pre-empted by *V. pedata* in many places a little farther west, for instance on deforested slopes of the Kettle Range. The division of the leaves in this species seem to be a xerophytic adaptation, serving a similar purpose as the hirsuteness of *V. sororia*.

In some places, *e. g.* near the Lake Shore in section 36, Town of Oak Creek, the last named species shares its dry habitat with *Viola Labradorica*. But more often that species is found in the damp, almost swampy places in the forest, where elm, black ash and red maple indicate the great moisture content of the soil. Here the ground is often largely occupied by mosses, and among these the low, much-branching plants, with their tangle of thin, superficial roots and little pale flowers are found. The habit of this species forms a striking contrast to that of its mesophytic cousins, like *V. Scabriuscula* or *Canadensis*. Where it grows copiously, it forms carpets on the ground, and might almost be called cespitose. In its neighborhood in such damp, mossy localities one is quite apt to find also the smallest of our violets, *V. blanda*. Both of these species are distinguished for their small size. But the peculiarity of *V. Labradorica* which is most interesting in the present connection is that it seems to flourish equally well in decidedly dry and pronouncedly wet situations. *V. Labradorica* is closely allied to the European *V. canina*, in fact so closely that some taxonomists will give it only varietal rank. (*V. canina* Muehlenbergii.) Now the European form is found in very dry localities, such as gravel slopes where the dominant vegetation consists of xerophilous grasses like *Festuca ovina*, or among the heather. There must be something in common between the two apparently so very different stations in which *Viola Labradorica* is found, and that common quality must be something which favors xerophytic adaptations. For the low growth and semi-cespitose habit of this species is a fairly pronounced indication of xerophily.

It seems to me that the similarity consists in this: In the dry places, especially the gravelly, strongly insolated slopes, there is very little humus. What little there may be found is sometimes sour or "raw"; in fact the dense tangle which roots often form in such localities is well known for its tendency to produce sourness by hindering aeration. Similar sour humus is found in the wet, swampy forests. Sour humus makes it more difficult for the roots to absorb moisture, and consequently it becomes necessary for the plant to reduce the transpiration. The lack of oxygen and assimilable forms of nitrogen in such soils still further induces a weakening of physiological activity. Now the series of *Viola* species outlined above shows clearly that the number and importance of xerophilous adaptations increases in inverse proportion of the presence of fresh, well-aerated humus, from the maple-beech forests to the dry hillsides on the one hand and the boggy elm and black ash forests on the other. Does not this circumstance indicate that there must be some causal connection between the quality of the humus and the occurrence of xerophytic characters?

It will be noticed, however, that there is a marked difference in the kind of adaptation between the dry and wet xerophytic stations. In the dry localities the most conspicuous feature is hairiness and next to it the rolling in of the leaf edge. In the swamp, what one notices most of all is the reduction in size, both of the plant as a whole and the proportion of the various organs of assimilation and transpiration. *V. Labradorica* is one of the smallest of our violets, both as regards length of stems and breadth of leaves. (The flowers are also smaller than in most other species.) *V. blanda* is smaller still. European species in similar stations, like *V. palustris*, which grows in sphagnum bogs, and *V. biflora*, which is found in gulches and on rocks where the water is constantly dripping, are also among the smallest of violets. On the other hand, *V. sororia* does not appear a bit less vigorous and full-sized than its cousin *V. obliqua*, though the latter has far better advantages as regards humus.

It will suggest itself therefore that the plants growing in sour humus have a tendency towards reduction in size, and a glance at other species than those of the genus *Viola* confirms this impression. Although hairiness is not entirely absent in bog plants, it is uncommon (8); but nearly all such species are distinguished by small leaves. This is true of many *Ericaceae*, and of conifers, such as tamarack and spruce. In very bad localities, such as sphagnum bogs, the spruce which occasionally grow there

(8) See Warming, Op. cit., page 174.

suffer an individual dwarfing, so that such a tree, although but a few feet high, may be a hundred years old.

The results which appear to flow from the above observations are the following:

1. The occurrence of more or less xerophytic species of *Viola* in a given locality depends on the amount and quality of humus in the soil.
2. Scantiness of humus favors specific adaptations for reducing transpiration, but does not diminish the vigor of growth; sourness of the humus tends to produce dwarfishness both of the whole plant and its separate parts.

The case of *Viola obliqua* growing in a sedge marsh, as mentioned above, does not necessarily militate against the second conclusion. It is by no means uncommon to find colonies of a species in a station not at all adapted to its growth. But such colonies are apt to be transitory; the numbers and individual vigor of the members is likely to diminish with each generation, until they disappear. I am unable to state how long *V. obliqua* has been in the marsh in question, but it will be interesting to watch its future history. It is probable that it will gradually disappear, unless the marsh should dry up and its soil become less sour; or unless the invaders should develop a variation which would adapt it to the new conditions.

Flowers Adapted to Flesh-Flies.

By DR. S. GRAENICHER.

The flies which are to be considered in the present paper, in regard to their relations to certain flowers, agree more or less in their food-habits, and are members of the families Sarcophagidae, Muscidae and of a few other closely allied families. They are the scavengers among the flies, feeding either in their larval state or as perfect insects on decaying organic matter, but also resorting to flowers in search of honey and pollen. Some of these are popularly known as flesh-flies, carrion-flies, dung-flies, etc., according to the nature of the substances to which they usually pay their attention. They are guided to these substances by the putrid odor emanating therefrom, and for this reason we might expect any flower, producing a similar odor, to be especially attractive to them. Delpino has given an account of two species of *Stapelia* from the Cape of Good Hope, plants belonging to the family Asclepiadaceae, the flowers of which are carrion-scented and are visited by flesh-flies (sapromyophilous). The Papaw, *Asimina triloba*, Dunal, a plant well known in this country, especially throughout the Southern States, on account of its edible fruit, produces dark purple flowers which are also sapromyophilous. From Southern Illinois Robertson (1) has reported the visits of 9 flies to these flowers, seven of which are flesh-flies, or other flies of similar food-habits. At Firenze, in Italy, Delpino observed seven species of flies on the flowers of cultivated specimens of the Papaw.

In our surroundings there occur three species of *Smilax* (family Smilacaceae), two of which, *S. ecirrhata* and *S. herbacea*, produce flowers of a disagreeable odor, as the name carrion-flower, given to one of them, implies, while the flowers of the third species, *S. hispida*, are sweet-scented. In color and structure of the flowers all three species agree, but they differ essentially in the odor of the flowers. For this reason they furnish a suitable material for determining the effect of the putrid odor on the various types of flower-visiting insects.

Besides these two sapromyophilous species of *Smilax*, a third plant is represented in our flora with flowers of an offensive odor, and of a dark purple color besides. This is *Euonymus atropurpureus*, the Waahoo, a member of the family Celastraceae, and it will

(1) Chas. Robertson, *Flowers and Insects*, Trans. Acad. Sc. St. Louis, Vol. VII, No. 6, pp. 154-5.

be considered in the course of this paper, with the same points in view as in the case of the *Smilax*-species.

The flowers of the latter have a greenish color. In a paper on the pollination of the greenish-yellow flowers of plants belonging to the genera *Caulophyllum*, *Ptelea*, *Rhamnus*, *Rhus* and *Sassafras*, Robertson (2) reviews the opinions held by various authors on the effect of the greenish color of the flowers on the insect-visitors. According to Delpino and Herm. Mueller, such flowers are very attractive to the larger flies (macromyiophilous), but the observations of Robertson show a distinct predominance of the flies in one species only, in *Sassafras officinale*, Nees, while in the remaining species (with the exception of *Caulophyllum thalictroides* (L.) Michx.), the lower bees, Andrenidae are the leading visitors. Of the dark colored flowers, such as are present in our Waahoo, (*Euonymus atropurpureus*) Delpino and Herm. Mueller express the view that they are visited mostly by flesh-flies (sapromyiophilous). As will be shown later on, the observations made on the Waahoo do not support this view.

SMILAX L.

The plants are dioecious, and produce simple flowers, which, in our own three species, present a very slight variation in structure, size and color. The staminate, as also the pistillate flowers, are gathered in axillary umbels and have a greenish-yellow color. In the staminate flowers the perianth-segments and stamens are present to the number of six, rarely of eight, and honey is secreted around the base of the filaments, as also along the inner surface of the perianth-segments. The pistillate flower has the same number of perianth-segments as the staminate, and contains an egg-shaped ovary, crowned with a three- or rarely a four-parted stigma. In addition to these parts it has abortive stamens, consisting of small filaments without anthers, which are appressed to the ovary, and never spread, as they do in the staminate flowers. The secretion of honey around the base of the ovary, and on the inner surface of the perianth-segments, is about the same as in the staminate flowers. The abundant whitish pollen of the staminate flowers renders the latter more conspicuous than the pistillate flowers, in which all the parts are of a greenish color.

The characters mentioned above are those common to all three of our species.

(2) Chas. Robertson, *Flowers and Insects*, XVII, Bot. Gaz., Vol. XXII (1896), pp. 154-165.

SMILAX ECIRRHATA, S. WATS. UPRIGHT SMILAX.

This is our earliest *Smilax*, blooming from May 19th to June 12th. The stems grow upright, varying in height between six and nine dm., and producing long-stalked axillary umbels, with numerous erect flowers of one cm. diameter. In the older flowers the lanceolate perianth-segments are somewhat reflexed. The staminate and pistillate flowers of plants, growing under the same conditions, open at about the same time. The stamens are strongly divergent, and all the anthers of the same flower shed their pollen synchronously. In the pistillate flower the abortive stamens are represented by four to six thin, poorly developed filaments, while the stigmatic lobes are comparatively large, and covered with numerous papillae. Nectar is secreted abundantly by both kinds of flowers, although in fine weather the flowers are mostly found with hardly any nectar, the supply having been exhausted by the very numerous insect-visitors. The putrid odor of the flowers, staminate as well as pistillate, is very distinct and may be likened to the smell of decomposing cheese.

Smilax ecirrhata presents a case of trioecism. Besides plants bearing either staminate or pistillate flowers, specimens are found with perfect (hermaphrodite) flowers exclusively. Such plants have appeared regularly for the last three seasons in a piece of woodland near the northern limits of Milwaukee, in Mineral Spring park. These perfect flowers are homogamous. Their anthers and ovaries are not as well developed, as is the case in the staminate and pistillate flowers, but they nevertheless furnish normal pollen and produce fruit. Trioecism has not yet been observed in any of our other species of *Smilax*.

On different days within the last four years, the following visitors have been taken on the flowers of *Smilax ecirrhata*:

A. Hymenoptera.

Andrenidae: (1) *Andrena*, sp. ♀, c. p.;* (2) *Augochlora vividula*, Sm. ♀, s. and c. p.; (3) *Halictus fasciatus*, Nyl., ♀ c. p.; (4) *H. fulvipes*, Sm. ♀, s. and c. p.

B. Diptera.

Tipulidae: (5) *Tipula graphica*, Doane; Syrphidae: (6) *Mesogramma geminata*, Say; Tachinidae: (7) *Gonia capitata*, DeG.; Muscidae: (8) *Hemichlora* sp.; (9) *Pollenia rudis*, Fabr.; (10) *Calliphora erythrocephala*, Meig.; (11) *C. vomitoria*, L.; (12) *Phormia regina*, Meig.; (13) *P. terrae-novae*, Desv.; (14) *Lucilia sylvarum*, Meig.; (15) *L. caesar*, L.; (16) *L.*

* ♀ Worker; ♂ Male; ♀ Female; s Sucking; c p Collecting Pollen; f p Feeding on Pollen.

sericata, Meig.; (17) *L. splendida*, Meig.; (18) *Pseudopyrellia cornicina*, Fabr.; (19) *Morellia micans*, Meig.; (20) *Myospila meditabunda*, Fabr.; (21) *Clinopera* sp.; Sarcophagidae: (22) *Helicobia heliciis*, Town.; (23-28) *Helicobia* spp.; (29) *Sarcophaga sarraceniae*, Riley; (30-32) *Sarcophaga* spp.; Anthomyidae: (33) *Drymeia* sp.; (34) *Ophyra* sp.; (35) *Phorbia fusciceps*, Zett.; (36-37) *Phorbia* spp.; Scatomyzidae: (38) *Scatophaga squalida*, Meig.; Ortalidae: (39) *Rivellia flavimana*, Loew; (40) *Chaetopsis aenea*, Wied.; Sepsidae: (41) *Sepsis violacea*, Meig.; (42) *Piophilha casei*, L.; Oscinidae: (43) *Chlorops grata*, Loew; (44) *C. assimilis*, Macq.; Borboridae: (45) *Borborus equinus*, Fall.;—all s. or f. p.

C. Coleoptera.

Elateridae: (46) *Cardiophorus obscurus*, Lec.; Malachiidae: (47) *Malachius montanus*, Lec.; (48) *M. thevenetii*, Horn; Cerambycidae: (49) *Leptura lineola*, Say; (50) *Acmaeops bivittata*, Say; Chrysomelidae: (51) *Orsodachna atra*, Ahr.; Anthicidae: (52) *Corphyra lugubris*, Say—all s.

D. Hemiptera.

Pentatomidae: (53) *Corimelaena lateralis*, Fabr. s.

Before drawing any conclusions from this list of visitors, it may seem advisable to first consider our other species of *Smilax* and then compare the results obtained.

SMILAX HERBACEA, L. CARRION-FLOWER.

The flowering season of this species is a continuation of that of the preceding species and extends from June 10th to July 13th. As a rule the plants attain a greater size than those of *S. ecirrhata*, growing to a height of 2 m. and sending off a number of branches. Besides this is a climbing species, another feature separating it from *S. ecirrhata*. As regards the flowers, they agree so closely with those of the preceding species, that a description of them may seem superfluous. Occasionally an umbel contains as many as eighty flowers, in which case it has a globular form.

Although disagreeable, the odor of these flowers is decidedly less putrid than that of the flowers of *S. ecirrhata*; it is a peculiar odor, reminding somewhat of rotten fruit.

The following list of visitors has been obtained through repeated observations during the last four seasons:

A. Hymenoptera.

Andrenidae: (1) *Andrena rugosa*, Rob. ♀, s. and c. p.; (2) *Augochlora vividula*, Sm. ♀, s. and c. p.; (3) *Agapostemon radiatus*, Say, ♀, c. p.; (4) *Halictus confusus*, Sm. ♀ s. and c. p.; (5) *H. inconspicuus*, Sm. ♀, c. p.; (6) *H. fulvipes*, Sm.

♀, c. p.; Eumenidae: (7) *Odynerus tigris*, Sauss., s.; Ichneumonidae: (8) *Tryphon seminiger*, Cress. s.; (9) *Campoplex dissitus*, Nort. s.; (10) *Cryptus* sp., s.

B. Diptera.

Culicidae: (11) *Culex stimulans*, Walk.; Syrphidae: (12) *Mesogramma geminata*, Say; Muscidae: (13) *Pollenia rudis*, Fabr.; (14) *Calliphora vomitoria*, L.; (15) *Phormia regina*, Meig.; (16) *P. terrae-novae*, Desv.; (17) *Lucilia sylvorum*, Meig.; (18) *L. caesar*, L.; (19) *L. sericata*, Meig.; (20) *Pseudopyrellia cornicina*, Fabr.; (21-22) *Clinopora* spp.; Sarcophagidae: (23) *Helicobia helices*, Town.; (24-26) *Helicobia* spp.; (27) *Sarcophaga sarraceniae*, Riley; (28-33) *Sarcophaga* spp.; Dexiidae: (34) *Myocera cremides*, Walk.; Anthomyiidae: (35) *Phorbia fusciceps*, Zett.; (36) *Leucomelina garrula*, Gig.—Tos.; Sapromyzidae: (37) *Lonchaea polita*, Say; (38) *Sapromyza lupulina*, Fabr.; (39) *Sapromyza* sp.; Ortalidae: (40) *Rivellia pallida*, Loew,—all s. or f. p.

C. Lepidoptera.

Rhopalocera: (41) *Neonympha eurytus*, F. s.;

D. Coleoptera.

Cerambycidae: (42) *Acmaeops atra*, Lec.; (43) *A. bivittata*, Say; (44) *Cyrtophorus verrucosus*, Oliv.; (45) *Euderces picipes*, Fabr.; Mordellidae: (46) *Mordella* sp.; Anthicidae: (47) *Corphyra collaris*, Say; (48) *C. lugubris*, Say—all s.

E. Hemiptera.

Capsidae: (49) *Lygus pratensis*, L.; (50) *Poecilocapsus lineatus*, Fabr.; (51-52) spp.—all s.

SMILAX HISPIDA, MUHL. GREENBRIER.

The main factor separating this from the two species considered above is the sweet scent of its flowers. These are open from June 5 to June 28, they bloom together with the late flowers of *S. ecirrhata* and with the flowers of *S. herbacea* during the first half of the latter's flowering season. *S. hispida* is a climbing species, and produces plants 10 to 12 dm. high with pendulous flowers. The number of flowers forming an umbel is small, on an average not exceeding fifteen, and on this account the umbels are less conspicuous than those of the other species.

In 1899 and 1900 the following insects were taken on the flowers:

A. Hymenoptera.

Nomadidae: (1) *Nomada maculata*, Cress ♀, s.; (2) *N. americana*, Kirby, ♀, s.; Andrenidae: (3) *Andrena forbesii*, Rob. ♀, s.; (4) *A. rugosa*, Rob. ♀, s.; (5) *Andrena* sp. ♂, s.; (6) *Agapostemon radiatus*, Say, ♀, s.; (7) *Halictus coria-*

ceus, Sm. ♀, s.; (8) *H. forbesii*, Rob. ♀, s.; (9) *H. 4 maculatus*, Rob. ♀, s. and c. p.; (10) *H. fulvipes*, Sm. ♀, s.; (11) *Sphcodes dichroa*, Sm. ♀, s.; (12) *S. confertus*, Say, ♂ s.; Prosopidae: (13) *Prosopis modesta*, Say, ♀, s.; Eumenidae: (14) *Odynerus foraminatus*, Sauss., s.; (15) *O. tigris*, Sauss. s.; Sphegidae: (16) *Ammophila vulgaris*, Cress., s.; Ichneumonidae: (17) *Tryphon* sp. s.; Evaniidae: (18) *Gasteruption incertum*, Cress., s.

B. Diptera.

Culicidae: (19) *Culex stimulans*, Walk.; Syrphidae: (20) *Syrphus ribesii*, L.; (21) *Allograpta obliqua*, Say; (22) *Mesogramma geminata*, Say; (23) *Helophilus similis*, Macq.; Tachinidae: (24) *Siphona geniculata*, DeG.; Muscidae: (25) *Polenia rudis*, Fabr.; (26) *Lucilia sylvarum*, Meig.; (27) *L. caesar*, L.; Sarcophagidae: (28) *Helicobia heliciis*, Town.; (29) *Sarcophaga*, sp.; Anthomyidae: (30) *Phorbia fusciceps*, Zett.; (31) *Coenosia* sp.; Scatomyzidae: (32) *Scatophaga squalida*, Meig.; Sapromyzidae: (33) *Lonchaea polita*, Say; (34) *Sapromyza lupulina*, Fabr.; (35) *S. quadrilineata*, Loew; Sepsidae: (36) *Sepsis violacea*, Meig.; Oscinidae: (37) *Meromyza americana*, Fitch; Agromyzidae: (38) *Agromyza jucunda*, v. d. W.,—all s. or f. p.

C. Coleoptera.

Anthicidae: (39) *Corphyra collaris*, Say, s.

D. Hemiptera.

Capsidae: (40) *Lygus pratensis*, L. s.

In the following table the results obtained from our three species of *Smilax* are brought together.

	s. ecurrata.	s. herbacea.	s. hispida.
HYMENOPTERA...Higher bees.....	.....	.....	2
Lower bees.....	4	6	11
Other Hymenoptera.....	.....	4	5
DIPTERA.....Syrphidae.....	1	1	4
Other flies.....	40	29	16
REMAINING VISITORS.....	8	12	2
Total.....	53	25	40

In the list of *Smilax hispida* with its sweet-scented flowers, different families of hymenopterous insects are represented, the higher bees as well as the lower bees, wasps and parasitic Hymenoptera. Among the flies the specialized Syrphidae are present to the number of four. The greenish color of the flowers does not seem to favor the visits of the larger Diptera (macromyiophilous). As regards the proportion of flies to Hymenoptera and other visitors, *Smilax hispida* corresponds with any sweet-scented flower of a similar structure, as for example any umbelliferous flower with freely exposed nectar, and it offers therefore nothing remarkable.

With *Smilax ecirrhata* and *S. herbacea* the case is different. The list of *S. ecirrhata* contains only four Hymenoptera, all of them lower bees (Andrenidae) against 41 flies. Among the latter only one is a Syrphus-fly, while of the remaining forty nearly all are flesh-flies or flies of similar food-habits. In the list of *S. herbacea* we find one Syrphus-fly against 29 other flies, and besides, there are ten Hymenoptera represented, most of them lower bees. In this species the preponderance of the flesh-flies and their allies is not as distinct as in the case of *S. ecirrhata* and this may be accounted for by the fact, that the odor of *S. herbacea* is not quite as strong and less putrid than that of *S. ecirrhata*. The flowers of the latter are attractive to the flies of the genera *Lucilia*, *Phormia*, *Calliphora*, *Morellia*, *Helicobia* and *Sarcophaga* to such an extent, that in favorable weather these flies may be seen swarming around the plants, especially when the latter occur in patches. More than once the presence of such flowers, hidden from view by the surrounding vegetation, has been betrayed to me by the gathering of the flies. The bad odor of the flowers does not prevent some of the lower bees of the genera *Andrena*, *Halic-tus*, *Agapostemon* and *Augochlora* from collecting pollen on the staminate flowers. Their visits are only occasionally observed and as these same bees rarely resort to the pistillate flowers, they are of little or no advantage as cross-pollinizers. The scarcity of the flower-flies of the family Syrphidae on the flowers of *S. ecirrhata* and *S. herbacea* is remarkable, and shows that the odor of these flowers is not agreeable to them. In fact, I have witnessed a single visit of the same species, *Mesogramma geminata* to each of the sapromyiophilous species of *Smilax*.

From the above we must infer that the flies which naturally resort to carrion and other decomposing substances are the principal visitors of *Smilax ecirrhata* and *S. herbacea*. They pay attention to both staminate and pistillate flowers, eagerly feeding on honey and pollen, and are undoubtedly of the greatest importance to these flowers as pollen-carriers.

EUONYMUS ATROPURPUREUS, JACQ. WAAHOO.

An account of the pollination of this species, together with a review of the literature dealing with the genus *Euonymus* and several of its species, was published by Robertson (3) in 1896.

This plant is not common in our neighborhood, but it occurs in several localities in patches, as for example in a large piece of woodland outside of the city limits, north of the Janesville Plank Road. In this locality the observations were made on specimens, varying in height from $1\frac{1}{2}$ to 3 m.

The dark purple flowers are very numerous, and emit a peculiar odor, which is quite different from the odor of the flowers of our sapromyiophilous species of *Smilax*, and resembles somewhat the smell of sour milk. In size the flowers agree with those from Southern Illinois as described by Robertson. The diameter of the flat, open flower is 8 mm. Each flower has in the middle a dark green, quadrate disc, in the angles of which the stamens are situated, while the style with its light green stigma arises from the center. Proterandry is well marked. The newly opened flower forms a cup, in which the anthers are dehiscent; later on the dark purple lobes of the corolla spread outwardly, and the stigma reaches maturity. Honey is secreted on the disc between the bases of the stamens. The style and the stamens are very short, hardly 1 mm. in length, and, for this reason, Robertson supposes that the feet and proboscides of the insects are the parts through which pollen is mostly transported. Many of the flowers are in a vertical position, but spontaneous self-pollination through the falling of pollen can hardly be expected, as the stigma becomes receptive rather late.

There were no flesh-flies among the 12 visitors taken by Robertson, although, as this author remarks, the disagreeable odor and dark purple color "would probably place it in Delpino's *Tipo melantino*, along with *Euonymus verrucosus*", suggesting an adaptation to flesh-flies.

On six days in June and July of the present year, I have observed these flowers under very favorable conditions; the weather was hot and clear and the plants were covered with flowers. The flowering season extends from June 22 to July 16.

In the following list 29 species of visitors are recorded, but the flowers are poorly attractive to insects, and the small number of individuals present contrasted strongly with the mass of flowers.

(3) Chas. Robertson, *Flowers and Insects*, Trans. Acad. Sc. St. Louis, Vol. VII, No. 6, pp. 157-9.

A. Diptera.

Tipulidae: (1) *Pachyrhina pedunculata*, Loew; Syrphidae: (2) *Syrphus americanus*, Wied.; (3) *S. ribesii*, L.; (4) *Allograpta obliqua*, Say; (5) *Baccha aurinota*, Walk.; Tachinidae: (6) *Siphona brevisrostris*, Coq.; (7) *Exorista pyste*, Walk.; (8) *E. cheloniae*, Rond.; (9) *Masicera* sp.; (10) *Peleteria robusta*, Wied.; Muscidae: (11) *Pollenia rudis*, Fabr.; (12) *Phormia regina*, Meig.; (13-14) *Clinopera* spp.; Sarcophagidae: (15) *Helicobia* sp.; (16-19) *Sarcophaga* spp.; Anthomyidae: (20) *Spilogaster* sp.; (21-22) *Mydaea* spp.; (23) *Ophyra* sp.; (24) *Phorbia fusciceps*, Zett.; (25) *Pegomyia* Sp.; Sapromyzidae: (26) *Sapromyza quadrilineata*, Loew; Ortalidae: (27) *Rivellia flavimana*, Loew; (28) *Scoptera vibrans*, L.—all s. or f. p.

B. Coleoptera.

Lampyridae: (29) *Ellychna corrusca*, s.

From this list we may infer that the flowers of *Euonymus atropurpureus* are attractive to flies in general, but not particularly to flesh-flies. Syrphidae appear also on the flowers, and of these the two species of *Syrphus*, figuring on the list, furnished the majority of the visitors on one occasion, on July 4. Of bees I have never witnessed a single visit, although five species of Andrenidae were taken on the flowers by Robertson, as may be seen from the following table:

	Andrenidae.	Syrphidae.	Other Diptera.	Coleoptera.	Total.
Carlinville, Ill	5	4	1	2	12
Milwaukee, Wis.....	.....	4	24	1	29

A review of the facts presented in the foregoing, leads to the following conclusions, regarding the effect of the odor of the flowers of our *Smilax*-species and of *Euonymus atropurpureus* on the various types of insect-visitors.

1. The sweet-scented flowers of *Smilax hispida* offer nothing remarkable in this respect, they agree in a general way with any sweet-scented flowers of a similar structure.

2. The flowers of *Smilax ecirrhata* and *Smilax herbacea*, with a putrid odor, are adapted to flesh-flies and the like, while those

of *Euonymus atropurpureus* with a disagreeable but not putrid odor are attractive to flies in general.

3. The specialized flies of the family *Syrphidae* avoid the putrid-scented flowers of *Smilax cecirrhata* and *Smilax herbacea*, but they frequent the flowers of *Euonymus atropurpureus*.

4. The disagreeable odor of the flowers of the two *sapromyiophilous Smilax-species*, as well as of *Euonymus atropurpureus* does not prevent the lower bees of the family *Andrenidae* from visiting these flowers.

Additions to the Flora of Milwaukee County.

By W. J. BENNETTS.

A Third Supplement to "The Flora of Milwaukee County" by W. M. Wheeler.

The following list is in part based on collections and observations made by myself during the past season of 1901. About one-third of the 90 names mentioned, however, have been contributed by five of our local botanists, viz.: W. Finger, P. Wells, H. Russell, J. A. Brandon and E. Bruncken. Acknowledgment is especially due to Mr. Finger who has furnished 19 of the species listed.

A notable feature of this list is the comparatively large number of western species—about 10 may be placed in this class—that the railroads have brought into this region. Some of these, like *Allionia nyctaginea* and *Artemisia gnaphalodes*, have apparently firmly established themselves, and may in time bring about a considerable change in the composition of our local flora. Hence lists which record the appearance of such species in our midst should prove of much interest to future botanists.

The nomenclature followed is that of Britton & Brown's "Illustrated Flora of the Northern United States and Canada" edition of 1898.

List of Species.

- 832 *Acer spicatum* Lam. Mountain Maple. In a small cedar swamp in section 20, Town of Milwaukee.
- 833 *Aenida tamariscina tuberculata* (Moq.). Uline & Bray. Under the Sixteenth street viaduct near the water's edge.
- 834 *Allionia hirsuta* Pursh. Hairy Umbrellawort. West of the town of North Greenfield, west of Wauwatosa, and on the South Side in Chase's Valley; in each case along or near the railway tracks. (W. Finger.)
- 835 *A. nyctaginea* Michx. Heart-leaved Umbrella-wort. West of Wauwatosa and of North Greenfield, and in the Menomonee Valley about Twenty-Fourth street; spreading rapidly wherever it has gained a foothold. (Wm. Finger.)
- 836 *Amaranthus blitoides* S. Wats. Prostrate Amaranth. A common weed along railway tracks, along streets, and in waste places.

ERRATUM.

(In the second supplement in Bulletin No. 3., Vol. 1)

- 826. *Trillium nivale* Riddell. March 26th should be given as its earliest known blooming date and not April 19th.

- 837 *Ambrosia trifida integrifolia* (Muhl.) T. & G. Entire-leaved Ragweed. Along the Milwaukee River at Lindwurm, and in the Menomonee Valley just south of the Grand Avenue viaduct. (H. Russel.)
- 838 *Amelanchier spicata* (Lam.) De C. Low June Berry. At the top of the bluff of the Menomonee Valley, just northwest of the Wells street viaduct.
- 839 *Amaranthus hybridus paniculatus* (L.) Uline & Bray. In boggy flats along the Menomonee and Milwaukee Rivers.
- 840 *Anogra pallida* (Lindl.) Britton. White-stemmed Evening Primrose. On newly graded land belonging to the railroad companies near the city limits, and the Kinnickinnik River.
- 841 *Andropogon scoparius* Michx. Broom Beard-grass. In Bay View near the rolling mills.
- 842 *Arctostaphylos Uva-Ursi* (L.) Spreng. Red Bearberry. On the face of the lake bluffs about a mile north of the village of Whitefish Bay.
- 843 *Anemone Canadensis* L. Canada Anemone. Common along the Prairie du Chien divisions of the M. & St. P. Ry. in Wauwatosa near the Hawley road; also near the Lisbon road at the Waukesha county line, along Oak Creek, and in a few other scattered localities. (W. Finger.)
- 844 *Anthemis arvensis* L. Field Camomile. Along Lincoln avenue west of Forest Home.
- 845 *Apocynum hypericifolium* Ait. Clasping-leaved Dogbane. Common this year on vacant ground along Forest Home Avenue opposite Pilgrim's Rest Cemetery.
- 846 *Arabis brachycarpa* (T. & G.) Britton. Purple Rock Cress. In the Menomonee Valley woods near the stone quarries.
- 847 *Artemisia gnaphalodes* Nutt. Prairie Mugwort. In the railway yards at the foot of Florida street, in the Menomonee Valley at Twenty-Third street, and on waste ground in a few other parts of the city.
- 848 *Artemisia biennis* Willd. Biennial Wormwood. Not rare within the city limits, and also scattered throughout the county. (H. Russel.)
- 849 *Aster ericoides* L. White Heath Aster. In section 6 of the town of Greenfield near the Waukesha county line, also along the C. & N. W. Ry. opposite the cement works.
- 850 *A. paniculatus* Lam. Tall White Aster. Near the springs in Mineral Spring Park.
- 851 *A. puniceus lucidulus* A. Gray. In section 5,, town of Greenfield along railway tracks near a tamarack swamp.
- 852 *Atriplex hastata* L. Halberd-leaved Orache. Along the streets of the city. (W. Finger.)
- 853 *Betula lenta* L. Black or Sweet Birch. Has been found in section 11, Town of Greenfield, near Lincoln avenue. It is not rare in Ozaukee county.
- 854 *Berteroa incana* (L.) D. C. Hoary Alyssum. In section 5, Wauwatosa, north of the Lisbon road in a field. (W. Finger.)
- 855 *Boltonia asteroides* (L.) L'Her. Aster-like Boltonia. In section 21, Town of Lake, near the intersection of the old Chicago road and

- Clement avenue. Also in section 33, Oak Creek, near the county line. (W. Finger.)
- 856 *Bromus secalinus* L. Cheat or Chess. In waste places and grain fields.
- 857 *Cardamine hirsuta* L. Hairy Bitter-cress. In Reynolds' Woods, section 6, Town of Greenfield. (W. Finger.) Also in boggy places in Wauwatosa.
- 858 *Carex Sartwellii* Dewey. Sartwell's Sedge. In a tamarack, section 5, Greenfield.
- 859 *Cardamine Pennsylvanica* Muhl. Pennsylvanian Bitter-cress. In Johnson's Woods, west of Soldiers' Home. (P. Wells.)
- 860 *C. arenicola* Britton. Sand Bitter-cress. In the Menomonee Valley near the quarries.
- 861 *Cassia Chamaecrista* L. Large-flowered Sensitive Pea. In a vacant lot on Oakland avenue, growing with *Melilotus alba*.
- 862 *Cenchrus tribuloides* L. Hedgehog Grass. In Bay View, south of the rolling mills.
- 863 *Croton Texensis* (Klatzsch) Muell. Arg. Texas Croton. Near the Kinnickinnic River at the city limits, growing with *Anogra pallida* on the land of the North-Western Railway Co.
- 864 *Cyclanthera dissecta* (T. & G.) Arn. Cut-leaved Cyclanthera. In the Menomonee Valley flats opposite Twenty-Third street.
- 865 *Cymbalaria cymbalaria* (L.) Wettst. Kenilworth Ivy. A weed in city gardens. (W. Finger.)
- 866 *Cyperus flavescens* L. Yellow Cyperus. In a tamarack in section 5, Town of Greenfield.
- 867 *Datura Tatula* L. Purple Stramonium. On empty lots Twenty-Ninth and Wright streets. (J. A. Brandon.)
- 868 *Delphinium Carolinianum* Walt. Carolina Larkspur. Found occasionally in waste places within the city.
- 869 *Dryopteris spinulosa* (Retz.) Kuntze. Spinulose Shield-fern. In a tamarack, section 5, Town of Greenfield (W. Finger.)
- 870 *D. spinulosa intermedia* (Muhl.) Underw. In section 27, Town of Lake, in a former tamarack.
- 871 *Eragrostis Eragrostis* (L.) Karst. Low Eragrostis. In Bay View.
- 872 *Falcata Pitcheri* (T. & G.) Kuntze. Pitcher's Hog Peanut. Common on the lake bluffs at Whitefish Bay.
- 873 *Galium tinctorium* L. Wild Madder. In Pierron's grove, section 18, Town of Milwaukee.
- 874 *Gentiana flavida* A. Gray. Yellowish Gentian. In a ravine on Dr. Schneider's farm at Fox Point. (W. Finger.)
- 875 *Gleditsia triacanthos* L. Honey Locust. Common along the Lisbon Road near the city limits, and along many other roads throughout the county.
- 876 *Helianthus tuberosus* L. Jerusalem Artichoke. In the Menomonee Valley near the Hawley Road, and in Mineral Springs Park between the railway embankment and the river.
- 877 *H. Maximiliani* Schrad. Maximilian's Sunflower. On the sides of a railway embankment at North Greenfield.

- 878 *Juniperus nana* Willd. Low Juniper. Frequent south in woods and pastures near the lake.
- 879 *J. Virginiana* L. Red Cedar. In woods in the Town of Franklin.
- 880 *Koellia Virginiana* (L.) McM. Virginia Mountain Mint. Along the east bank of the Milwaukee River between River Park and Mineral Spring Park.
- 881 *Lactuca hirsuta* Muhl. Red Wood-lettuce. In Wauwatosa along fences.
- 882 *L. Floridana* (L.) Gaertn. False or Florida Lettuce. Near the Milwaukee River above Mineral Spring Park.
- 883 *Liriodendron Tulipifera* L. Tulip-tree. There are a few shade trees of this species on the East side.
- 884 *Lithospermum canescens* (Michx.) Lehm. Hoary Puccoon. West of North Greenfield along the North-Western Ry. tracks. (W. Finger.)
- 885 *Lonicera Sullivantii* A. Gray. Sullivant's Honey-suckle. Our commonest species of *Lonicera*, frequent in the thickets of the Menomonee Valley, and less so along the Milwaukee River; also occurs in the growths of *Corylus* and *Hamamelis* that border many of our upland woods. This is doubtless the *L. flava* of Wheeler's list.
- 886 *Lycopus rubellus* Moench. Stalked Water Hoarhound. In the Menomonee Valley just above the Wells Street viaduct (J. A. Brandon). Also in Pierron's grove, section 18, Town of Milwaukee.
- 887 *Lychnis alba* Mill. White Campion. This species has established itself and is abundant in the State Fair Grounds at North Greenfield. It is also occasionally found along the streets of the city. (P. Wells.)
- 888 *Matricaria inodora* L. Scentless Camomile. In vacant ground on Forest Home Avenue, opposite Pilgrims' Rest Cemetery.
- 889 *Melampyrum lineare* Lam. Narrow-leaved Cow-wheat. Has been found at Whitefish Bay.
- 890 *Meibomia pauciflora* (Nutt.) Kuntze. Few-flowered Tick-trefoil. H. Russel has found this species in Lake Woods.
- 891 *Oxalis corniculata* L. Yellow Procumbent Wood-sorrel. A common weed growing with *O. stricta* in city gardens. (W. Finger.)
- 892 *Panax quinquefolium* L. Ginseng. I found two plants during the past summer in a beech woods near the lake, in section 36, Town of Oak Creek.
- 893 *Parietaria Pennsylvanica* Muhl. Pennsylvania Pellitory. A weed in city gardens. (W. Finger.)
- 894 *Peramium pubescens* (Willd.) McM. Downy Rattlesnake-plantain. In section 32, Town of Oak Creek, near the county line. (W. Finger.)
- 895 *Pentstemon Digitalis* (Sweet.) Nutt. Foxglove Beard-tongue. In section 5, Wauwatosa, and in section 16, Town of Milwaukee. (W. Finger.)
- 896 *Physalis heterophylla* Nees. Clammy Ground-cherry. In stubble fields, section 9, Town of Oak Creek. (J. A. Brandon.)

- 897 *P. Virginiana* Mill. Virginia Ground-cherry. Was found during the past season growing in considerable numbers in open ground in section 34, Greenfield, just east of the State Fair Grounds.
- 898 *Physostegia parviflora* Nutt. Western Lion's Heart. In the Menomonee Valley near the Grant Marble Works.
- 899 *Polygala Senega latifolia* T. & G. In woods near the waterworks in Wauwatosa.
- 900 *Potamogeton pectinatus* L. Fennel-leaved Pondweed. There is a specimen in the Public Museum herbarium collected by T. A. Bruhin along the shores of Lake Michigan at Milwaukee.
- 901 *Polygonum emersum* (Michx.) Britton. Swamp Persicaria. In muddy flats of the Menomonee Valley, Wauwatosa.
- 902 *P. orientale* L. Prince's Feather. In many vacant lots and waste places within the city limits.
- 903 *Ranunculus septentrionalis* Poir. Marsh Buttercup. By the side of M. & St. P. Ry. tracks west of Soldiers' Home. (J. A. Brandon.)
- 904 *Ribes prostratum* L'Her. Fetid Currant. Has been found in Wauwatosa by F. Runge. It occurs not rarely in the counties to the north of us.
- 905 *R. gracile* Michx. Missouri Gooseberry. Common throughout the county.
- 906 *Ricinus communis* L. Castor Oil Plant. In waste places along Clybourn street.
- 907 *Robinia Pseudacacia* L. Black Locust. Common along fences and roads in Wauwatosa.
- 908 *Rubus Baileyanus* Britton. Bailey's Blackberry. In woods near the cement works on the Milwaukee River. (W. Finger.)
- 909 *Rhynchospora glomerata* (L.) Vahl. Clustered Beaked Rush. In the Menomonee Valley near Mitchell Park.
- 910 *Sericocarpus linifolius* B. S. P. Narrow-leaved white-topped Aster. Near North Milwaukee.
- 911 *Solidago rigida* L. By the roadside just north of the cement works on the Milwaukee River.
- 912 *Solanum Carolinense* L. Horse Nettle. In the Menomonee Valley about Thirtieth street. (W. Finger.)
- 913 *Stipa spartea* Trin. Porcupine Grass. In Bay View south of the rolling mills.
- 914 *Thalictrum purpurascens* L. Purplish Meadow-rue. At Whitefish Bay and elsewhere in damp soil.
- 915 *Thalesia uniflora* (L.) Britton. One-flowered Broom-rape. North of Whitefish Bay (W. Finger). Also in thickets near the springs in Mineral Spring Park. (Dr. S. Graenicher.)
- 916 *Triglochin palustris* L. Marsh Arrow-grass. Common along the lower face of the lake bluffs at Whitefish Bay on the boggy terraces.
- 917 *Veronica Byzantina* B. S. P. Byzantine Speedwell. At Fox Point, a weed in gardens (W. Finger). It has been found also within the city.
- 918 *Vicia sativa* L. Common Tare. Common in grain fields north of Whitefish Bay, also in city gardens.

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- 919 *Viola scabriuscula* (T. & G.) Schwein. Smoothish Yellow Violet. Common in rich moist woods.
- 920 *V. ovata* Nutt. Ovate-leaved Violet. In the Menomonee Valley just west of the Wells street viaduct, and in section 36, Oak Creek. (E. Brunken.)
- 921 *V. sororia* (Willd.) Woolly Blue Violet. Frequent throughout the county. (E. Brunken.)

Contribution Towards a List of Milwaukee County Fungi.

By CHAS. E. BROWN and VALENTINE FERNEKES.

Since the fall of 1899, an effort has been made by ourselves, assisted by other members of the Wisconsin Natural History Society, to establish at the Milwaukee Public Museum for the purpose of public instruction, a collection of the more common species of Milwaukee County fungi. The seasons of 1900 and 1901 being particularly favorable to such growth, a considerable number of these and of the less frequently occurring forms were collected in various parts of the city and county, and many of these have been prepared, determined and placed upon exhibition in the museum halls.

In Milwaukee as elsewhere, the number of persons, who are learning to appreciate the worth of fleshy fungi as a welcome addition to our table delicacies, is on the increase and such a collection, as we have attempted to institute, has already been, we have reason to believe, of material aid to many in this respect.

Of the number and distribution of our local species but little is known, and it is hoped that the present work may be continued and that the material thus assembled may prove of value in case the publication of a complete list of Wisconsin fungi is ever attempted.

In the preparation of the present list, the works of Peck and other authors have been freely consulted.

To the Messrs. E. E. Teller, Ernest Bruncken, J. A. Brandon, W. J. Bennetts, A. F. Laue and other members of the Wisconsin Natural History Society, we are indebted for assistance in collecting, and to Rev. Chas. J. McNeill and Dr. R. A. Harper of Madison, for determining certain doubtful forms.,

Of the 100 species listed, 44, or numbers: 1, 4, 5, 6, 11, 13, 14, 15, 20, 23, 26, 29, 31, 33, 34, 35, 49, 51, 52, 53, 54, 56, 57, 59, 60, 61, 62, 65, 67, 70, 71, 76, 77, 78, 80, 85, 89, 90, 93, 94, 95, 96, 98 and 100 have been previously recorded from other parts of the state in W. F. Bundy's "Partial List of Wisconsin Fungi," published in Vol. I. of the Geology of Wisconsin, 1873-76.

- *1. *Agaricus campestris*, Linn. Common Mushroom. Appears as early as May and occurs in the greatest abundance in September and October. Common on lawns, lots and parks all over the city. Sometimes in patches of considerable extent.

2. *Agaricus arvensis*, Schaeff. Horse Mushroom. Common in the fields and pastures of the county. Also occasionally occurring in the city.
3. *Agaricus argenteus*, Braendle. Silver Agaric. Specimens collected in mixed woods opposite Humboldt on the Milwaukee River. September 29, 1901.
- *4. *Agaricus silvicola*, Vittad. Wood Agaric. On ground in mixed woods opposite Humboldt on the Milwaukee River. October 8, 1901.
- *5. *Amanita phalloides*, Fr. Deadly Amanita. In Johnson's and other woodlands west of the city. October 1900 and 1901. Occasional specimens of the yellow form have also been found there.
- *6. *Amanita verna*, Bull. Spring Amanita. Growing on grass lots near Oakland Ave. in the city. October 10, 1900.
7. *Amanita frostiana*, Pk. Frost's Amanita. A number of these richly colored plants were obtained from a hollow beneath the roots of a large oak near the Blue Mound Road in Town Wauwatosa on October 11, and again on October 20, 1901.
8. *Amanitopsis vaginata*, Roze. Sheathed Amanitopsis. In mixed woods near Whitefish Bay, September 13, 1901.
9. *Amanitopsis vaginata*, Roze, var. *fulva*, Schaeff. Single specimens have been found in mixed woods near Whitefish Bay, September, 1901.
- *10. *Amanitopsis strangulata*, Roze. Choked Amanitopsis. August 30, 1901. Several specimens were obtained in open woods near the Country Club.
- *11. *Armillaria mellea*, Vahl. Honey-colored Armillaria. Common in the woods of the country. Also along city streets, growing at the bases of trees and from buried roots on lawns. Growing in great quantity from cracks on top of rotting stumps and about the bases of trees and stumps in the southern part of Johnson's woods, Town Wauwatosa, during late September and early October, 1901.
12. *Clavaria botrytes*, Pers. In mixed woods near Whitefish Bay, September 12, 1901.

- *13. *Clavaria cristata*, Pers. Crested Clavaria. The most common of our local clavarias. Growing in rich soil near logs and stumps, August and September.
- *14. *Clavaria coralloides*, Linn. Coral Clavaria. Several fine specimens found in Johnson's woods, Town Wauwatosa, August 27, 1900.
- *15. *Clavaria inaequalis*, Fl. Unequal Clavaria. Solitary plants collected in woods, opposite Humboldt, on the Milwaukee River, September, 1899.
- 16. *Clavaria muscoides*, Mcllv. Moss Clavaria. In pasture, near Mineral Spring Park, October 17, 1900.
- 17. *Clavaria pistillaris*, Linn. Pestle-like Clavaria. Several fine lots of this plant, of a light reddish-brown color, were collected in mixed woods, near the Country Club, October 10, 1900.
- 18. *Clavaria pyxidata*, Pers. Box-tipped Clavaria. Found but once. Specimens growing in rich soil near a rotting log in Reynolds' woods, near Layton Park, October 9, 1900.
- 19. *Clavaria craniformis*, Schw. Skull-shaped Lycoperdon. In open woods, near Lake Park, October 11, 1900.
- *20. *Clavaria gigantea*, Batsch (*Lycoperdon giganteum*, Batsch). Giant Puff Ball. Common throughout the county in wooded pastures and fence corners during September and October in favorable seasons.
- 21. *Clitocybe decastes*, Gr. Clustered and single. Growing on piles of bran and sawdust near North and Oakland Avenues, September 15, 1901.
- 22. *Clitocybe illudens*, Schw. Deceptive Clitocybe. Appears to be common throughout the country. We have collected it as early as August 12 and up to October 15, generally from stumps and roots of oak and elm.
- *23. *Clitocybe laccata*, Scop. Lac Clitocybe. Growing in grass in Johnson's woods, Town Wauwatosa, and in mixed woods near Lake Woods, September 12, 1900.
- 24. *Clitocybe media*, Pk. Intermediate Clitocybe. In mixed woods near the Country Club, October 17, 1900.
- 25. *Clitocybe multiceps*, Pk. Many-headed Clitocybe. Plants growing singly and in clusters on well-manured lawn at

- Sixteenth and Prairie Sts., October 10, 1901. Also near North Avenue, October 6, 1901.
- *26. *Clitocybe nebularis*, Batsch. Clouded Clitocybe. In mixed woods near Whitefish Bay, October 10, 1901.
27. *Clitocybe robusta*, Pk. Robust Clitocybe. In mixed woods opposite the Cement Mills on the Milwaukee River, October, 1900. Tompkins' woods, South Milwaukee, October 5, 1901.
28. *Clitophilus abortivus*, B. & C. Aborted Clitocybe. With aborted form in Johnson's woods, September 6, 1900. In *crataegus* thickets in Downer College woods, October 10, 1900.
- *29. *Clitophilus prunulus*, Scop. Prune Mushroom. With aborted form in mixed woods near Wauwatosa, September 23, 1901. Tompkins' woods, South Milwaukee, October 5, 1901. Near Mineral Spring Park.
30. *Collybia radicata*, Rehl. Rooted Collybia. Common in woods throughout the county. Occurring also on lawns in the city. We have collected it from early August to October.
- *31. *Collybia velutipes*, Curt. Velvet-footed Collybia. Common in the city and county, especially in the autumn on stumps and tree trunks. We have found it as late as November 24.
32. *Collybia dryophila*, Bull. Oak-loving Collybia. In mixed woods near the Country Club, October 24, 1900.
- *33. *Coprinus atramentarius* (Bull) Fr. Very common, especially along the city streets on lawns, etc. August too as late as November 1. The scaly form is probably the least common.
- *34. *Coprinus comatus*, Fr. Shaggy-mane. During September and October, one of our most common mushrooms. Growing in greatest quantity on filled land and rubbish piles beneath the Sixteenth Street viaduct. The horse manure which sifts through the flooring and blows over the side of that structure has greatly enriched the ground beneath, making the spot a favorable one for the growth of this and other fleshy fungi. Occuring also on lawns and vacant lots in the city.

- *35. *Coprinus micaceus* (Bull) Fr. Glistening *Coprinus*. Very common, especially along the city streets. Spring to late autumn. In large clusters and successive crops.
- 36. *Coprinus tomentosus* (Bull) Fr. Hairy *Coprinus*. A small cluster was found growing on an old broom in the basement of the Pabst Theatre Building, April 2, 1900. On dung heaps in the Menomonee Valley in the city, October 8, 1901.
- 37. *Daedalea unicolor* (Bull), Fr. On basswood stump in the Menomonee Valley, near the Miller Brewery, October, 1900.
- 38. *Dictyophora duplicata* (Bosc.), Ed. Fister. Net Bearer. A number of plants were collected in mixed woods near Mineral Spring Park, October 19, 1900.
- 39. *Favolus europaeus*, Fr. In Johnson's woods on dead twigs and branches, July 10, 1901. Near Wauwatosa village.
- 40. *Helvella crispa*, Fr. White *Helvella*. In mixed woods at Lindwurm, September 9, 1900.
- 41. *Helvella lacunosa*, Afzel. Pitted *Helvella*. Country Club woods, October 11, 1901.
- 42. *Hygrophorus virgineus*, Fr. Ivory Cap. In grassy places in woods, on the east side of the Milwaukee River, opposite Humboldt, October 31, 1900.
- 43. *Hydnum caput-ursi*, Fr. Bear's Head *Hydnum*. Handsome specimens of this and the three succeeding species have been collected after each heavy rain from the top and sides of two beech logs, in a raspberry thicket, in woods opposite Humboldt, on the Milwaukee River. During 1900, our first specimens were obtained at about the middle of August, and the last in early November, just before the first heavy frost. During 1901, they have been equally abundant at the same place, the different forms often touching each other, but not arranged in regular series of any kind. The fifth species being collected with the others for the first time.
- 44. *Hydnum caput-medusae*, Bull. Medusa's Head *Hydnum*. Also found on log at Reynolds' woods, October 4, 1901.
- 45. *Hydnum erinaceus*, Bull. Hedge-hog *Hydnum*.

46. *Hydnum acciculare*, Sac.
47. *Hydnum coralloides*, Scop. Coral Hydnum. On beech log in woods opposite Humboldt, on the Milwaukee River, September 19, 1901.
48. *Hypholoma incertum*, Pk. In woods on the Oaks Farm, Cudahy, August 23, 1901. Whitefish Bay, June to September, 1901.
- *49. *Hypholoma perplexum*, Pk. Perplexing *Hypholoma*. Base of oak tree, Siegel's Farm, Cudahy, October 4, 1901. In mixed woods near Fox Point, October 7, 1901.
50. *Hypholoma sublateralitum*, Schaeff. Brick-red *Hypholoma*. Common throughout the county. Growing on stumps and from underground roots. Occurs also in the city. During October and up to November 1, 1900, successive crops appeared from a wound on the limb of an elm, 20 feet from the ground, at Eleventh and Cedar Sts.
- *51. *Hypholoma lachrymabundum*, Fr. Weeping *Hypholoma*. Near 32nd and National Avenues, September, 1900.
- *52. *Lactarius chrysorrheus*, Fr. August 23, 1900. Johnson's woods, Town Wauwatosa.
- *53. *Lactarius insularis*, Fr. Tasteless *Lactarius*. September 10, 1901. In woods opposite the Cement Mills.
- *54. *Lactarius piperatus* (Scop.), Fr. Peppery *Lactarius*. We have collected this species from the middle of August to the last of September, near the Cement Mills, Downer College, and in Reynolds' woods on the Janesville Plank Road.
55. *Lepiota morgani*, Pk. Morgan's *Lepiota*. Four fine specimens, each measuring about 8 inches across the pileus and with a stipe about 8 inches high, were collected in a wet, grassy pasture at North Milwaukee, on September 15, 1900.
- *56. *Lepiota naucina*, Fr. Smooth *Lepiota*. Common on lawns, hillsides, pastures and cultivated fields near the city, from July to October. During a particularly wet summer season several years ago, this mushroom was so common in the potato fields of the county that wagon loads of it were brought in to market by the farmers.

- *57. *Lepiota procera*, Scop. Parasol mushroom. Common in pastures and open woods of the county and occasionally found growing on lawns in the city. We have collected it from late August to October.
58. *Lycoperdon Curtisii*, Berk (*Lycoperdon wrightii*, var *typicum*, Pk.). Curtis' Lycoperdon. September 29, 1900. Growing on grass lots near Lake Park.
- *59. *Lycoperdon cyathiforme*, Bosc. Cup-shaped Lycoperdon. October 20, 1900, Johnson's woods, Town Wauwatosa. October 10, 1900, in mixed woods near Whitefish Bay. October 15, 1901, near Carrollville.
- *60. *Lycoperdon gemmatum*, Batsch. Gemmed Lycoperdon. Common in woods and open places in the county, from the last of August to the middle of October.
- *61. *Lycoperdon pyriforme*, Schaeff. Pear-shaped Lycoperdon. Growing on rotting wood, stumps and logs in the county. Most abundant during October.
- *62. *Lycoperdon wrightii*, B. and C., var *seperans*, Pk. Wright's Lycoperdon. On grass lots near Lake Park, September, 1900. Not common.
63. *Marasmius oreades*, Fr. Fairy Ring Mushroom. On elevation in grassy pastures near North Milwaukee, September 30 to October 10, 1901. Forming rings 5 to 12 feet in diameter.
64. *Merulius tremellosus*, Schrad. Trembling *Merulinus*. Spread over bark of maple log in woods near the end of National Avenue, October, 1900.
- *65. *Morchella esculenta*, Pers. Esculent Morel. Specimen brought to us from Oak Creek, where it is occasionally gathered in small quantities after rains in late spring and early summer. It also occurs at Fernwood and in the Fish Creek ravine in the northern part of the county.
66. *Omphalia campanella*, Batsch. Bell *Omphalia*. Several fine clusters of thirty or more individuals were collected from the top of a rotting beech log in mixed woods opposite Humboldt on the Milwaukee River, August 26, 1901.
- *67. *Peziza aurantia*, Pers. Golden *Peziza*. In great numbers on the ground, Reynolds Woods, September 23, 1900; October 10, 1900, Downer College woods; September 12,

- 1901, Oaks' Farm, Cudahy; September 27, 1901, Johnson's woods, Town Wauwatosa.
68. *Peziza acetabulum*, Linn. Cup-shaped *Peziza*. June 13, 1901. A single specimen obtained in Johnson's woods.
69. *Peziza badia*, Pers. Bay-brown *Peziza*. Growing singly and clustered among oak leaves, at the margin of a slight depression, in clayey soil, at Johnson's woods, July 12, 1901.
- *70. *Peziza coccinea*, Jacq. Fairy Cup. Mitchell's woods, Layton Park, on fallen twigs. Usually a single specimen on a twig. September 23, 1900. Country Club woods, October 10, 1900.
- *71. *Phallus impudicus*, Linn. Fetid Wood-Witch. August, 1899. In woods near 39th Avenue, in the city. September 12, 1900. In woods near Downer College.
72. *Pholiota adiposa*, Fr. Fatty *Pholiota*. Clusters of five to ten plants growing from wounds six feet up the trunk of a chestnut tree on the Deutscher Club grounds, in the city, September 25 to October 8, 1901. Specimens gathered from the same tree last year. Growing from wound on trunk of soft maple, 12th and State streets, September 23 to October 11, 1901. Reynolds' woods, Layton Park, October 4, 1901.
73. *Pleurotus dryinus*, Pers. Oak *Pleurotus*. A small cluster growing from a wound, on the trunk of an oak tree, near Whitefish Bay, October 17, 1900.
74. *Pleurotus ostreatus*, Jacq. Oyster Mushroom. Common from July to November on dead trunks and branches of elm and oak in the woodlands of the county. An unusual growth of large clusters observed on October 6, 1901, in the National Soldiers' Home grounds, covered the entire side of a dying elm tree [two and one-half feet in diameter] from the roots to a point about ten feet up the trunk.
75. *Pleurotus sapidus*, Kalchb. Savory *Pleurotus*. Collected from dead tree trunk in Johnson's woods, Town of Wauwatosa, October 15, 1900. Another large and handsome specimen was obtained from a log of green wood, which had lain for several months in the cellar of a residence, at 21st and Grand Avenue.

- *76. *Pleurotus ulmarius*, Bull. Elm *Pleurotus*. Very common, especially in the city, growing from pruned limbs or crotches of living elm trees, during September and October. Usually from two to three plants in a cluster.
- *77. *Pluteus cervinus*, Schaeff. Brown *Pluteus*. Common in mixed woods near Whitefish Bay, August and September, 1901. Occurring also at Cudahy and in Johnson's woods.
- *78. *Polyporus adusta*, Fr. Scorched *Polyporus*. On stump, in woods, at Buckhorn, Town Lake, October, 1901.
79. *Polyporus applanatus* (Pers.) Fr. Common *Polyporus*. The most common of our woody fungi. Growing on stumps and sometimes from wounds of living trees. Several interesting examples, where the fungus, projecting from a tree stump, had completely enveloped a young sapling which had grown up from the ground near it were brought to us by Rev. C. J. McNeill.
- *80. *Polyporus brumalis* (Pers.) Fr. Winter *Polyporus*. Specimens of this interesting fungus were found growing on a stump in mixed woods, opposite the cement mills, on the Milwaukee River, October 12, 1900.
81. *Polyporus frondosus*, Fr. Leafy *Polyporus*. Two large specimens of a grayish color were found growing on an old stump in woods near the Country Club, September 12, 1900. From roots of an oak near Whitefish Bay Village, October 4, 1901.
82. *Polyporus gilvus*, Schw. Growing on basswood stump, in the Menomonee Valley, west of the city, October 10, 1901.
83. *Polyporus lucidus* (Leys) Fr. Lucid *Polyporus*. On stump near Tippecanoe Lake, Town Lake, Milwaukee County, October, 1900.
84. *Polyporus resinosus*, ——. Resin *Polyporus*. On stumps near Whitefish Bay, October 12, 1900.
- *85. *Polyporus sulphureus* (Bull) Fr. Sulphur *Polyporus*. Fine specimens were collected from a large stump in Mitchell's woods, Town Greenfield, September 24, 1900; from trunk of living oak in Country Club woods, October 10, 1900; from dead oak trunk, Johnson's woods, Sep-

- tember 12, 1900; and from wounds on the bark and roots of a basswood tree near Wauwatosa, September 17, 1901.
86. *Polystictus cinnabarinus* (Jacq.) Fr. Red *Polystictus*. On oak stumps, Layton Park, October 21, 1900. Tompkin's woods, South Milwaukee, October 6, 1900.
87. *Polystictus conchifer*, Schm. On dead twigs, Menomonee Valley, April, 1901. On small trunks and limbs of ash, Johnson's woods, October 6, 1901.
88. *Polystictus versicolor* (L.) Fr. Many-colored *Polystictus*. Common throughout the county on stumps and branches of oak, maple, basswood, etc. Some very handsome growths were collected from the trunks of dead and dying peach trees in city gardens.
- *89. *Polystictus hirsutus*, Fr. Hairy *Polystictus*. Common in the county on stumps, limbs, etc.
- *90. *Psathyrella disseminata*, Pers. Scattered *Psathyrella*. Common on lawns and near bases of shade trees, along city streets, August and September, 1901. In woods at Oaks farm, Cudahy, September 10, 1901.
91. *Russula adusta* (Pers.) Fr. Scorched *Russula*. September 20, 1901. In mixed woods, opposite the cement mills; on the Milwaukee River. October 10, 1900, in Dahlman's woods, near Whitefish Bay.
92. *Russula alutacea*, Fr. Leathery *Russula*. Common during August and September, 1900 and 1901, in woods extending from the city limits to Whitefish Bay. September, 1901, in Johnson's woods, Town Wauwatosa.
- *93. *Russula emetica*, Fr. Emetic *Russula*. Specimens collected in Johnson's woods, Town Wauwatosa; in birch woods at Fox Point; and in woods near the Country Club, September, 1900 and 1901.
- *94. *Schizophyllum alneum*, (L.) Schroet. (*Schizophyllum commune*, Fries). Common throughout the county, on branches, trunks, etc. We have collected it on oak, hickory and linden.
- *95. *Scleroderma vulgare*, Fr. Common *Scleroderma*. October 23, 1900, and October 4, 1901, in woods, opposite Humboldt, on the Milwaukee River.

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- *96. *Strobilomyces strobilaceus*, Berk. Cone-like Boletus. July 31, 1900, in woods near Lake Station; August 12, 1900, in Reynolds' woods, on the Janesville Plank Road. August 20, 1901, in Johnson's woods, Town Wauwatosa.
97. *Trametes peckii*, Kalchb. Peck's Trametes. On cottonwood stump in the Menomonee Valley, west of the city, October, 1901.
- *98. *Tremella fimbriata*, Pers. Fringed Tremella. On oak stump, in mixed woods west of the cement mills, September 10, 1901.
99. *Tremella fuciformis*, Berk. Spindle-shaped Tremella. On leaf mold, in mixed woods near Lake Park, October 9, 1900.
- *100. *Tremella lutescens*, Pers. Yellow Tremella. Common on rotting limbs and logs of oak, in Country Club woods, October 10, 1900.
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*Mentioned in W. F. Bundy's List published in Vol. 1 of Geo. of Wis. (1873-'76.)

Notes on a Collection of Hamilton Fossils, from the Town of Bethany, Genesee Co., N. Y.

By CHARLES E. MONROE.

The writer's first acquaintance with Devonian fossils was made in connection with the hydraulic limestone beds in the neighborhood of Milwaukee. These beds are rich in the remains both of fishes and invertebrates and are remarkable for the mingling of forms which are elsewhere widely separated geographically and vertically. The study of these forms and their proper determination and correlation necessitated more extensive investigations and an acquaintance with the fossils of other localities. In the progress of such investigations trips have been made into Iowa, Michigan and Ontario and interesting collections secured at Hackberry Grove, Petoskey and Thedford, all famous localities for fossils. Last May a visit was made to the town of Bethany, in Genesee County, N. Y., where for the first time the writer had an opportunity to secure a large collection from the classical ground of the New York Hamilton. The principal localities visited were a couple of points on the line of the Lackawanna railroad, one a cut through a few feet of rock a mile and a half west of the village of East Bethany, the other the flat but narrow valley of a little brook crossing the railroad a mile and a half still farther west. A brick-yard by the highway, a mile south of the village, furnished good specimens of *Spirifer marcyi* and *Tropidoleptus carinatus*, being the only locality where these two species were obtained. In the shales exhibited on the banks of a stream flowing through the same farm a fine crinoid was obtained, and in the banks of the same stream at a point nearer the village many small fossils were found in concretions of iron pyrites, among the most notable being specimens of *Goniatites uniaugularis*. The water, however, was too high to permit a thorough examination of these shales, and far the larger portion of the collection was obtained from the slopes of the railroad cut and from low mounds of disintegrated material in the valley of the little brook first mentioned.

The railway cut near East Bethany is from twelve to fifteen feet in depth, the encrinal limestone showing at the top of the slope. There is also a cut many feet deep at the crossing of the little brook to the west; but the shales there exposed are apparently barren, except at the highest point, where a few large specimens of *Spirifer granulosus*, *S. mucronatus* and *Athyris spiriferoides* were found. At the bottom of this valley the encrinal lime-

stone is visible in the bed of the creek, dipping to the west. East of this point a few feet of the lower shales are seen, but they are mostly barren of fossils. This paper, however, is not intended as a study of horizons; but a list of the fossils collected will be given, with some notes on their geographical distribution and such other observations as may be suggested by a study of the specimens.

One thing especially noticeable is the striking resemblance between the Bethany and Thedford faunas. There is also a remarkable similarity in the manner in which the fossils are concentrated in both places in the neighborhood of the encrinal limestone, either in the limestone layer itself or in the strata immediately contiguous to it. The shales at Thedford are of a different character from those at Bethany, being lighter in color and softer, quickly breaking down into a tenacious clay. The limestone is similar in the two localities and holds the same position between great thicknesses of softer rocks.

Among the fossils first described from Thedford, but common to both localities, are the following—twenty-nine species in all—some of which have not before, so far as the writer is aware, been reported from New York:

Alveolites goldfussi, *Ascodictyon fusiforme*, *A. stellatum*, *Botryllopora socialis*, *Camarotoechia thedfordensis*, *Cladopora fischeri*, *C. roemeri*, *Cornulites intermedius*, *Favosites clausus*, *F. placenta*, *Fistulipora huronensis*, *F. subtrigona*, *Hederella canadensis*, *H. filiformis*, *Heliophyllum juvenc*, *Heterotrypa barrandei*, *H. moniliformis*, *Leptotrypa quadrangularis*, *Leiorhynchus laura*, *Monilopora antiqua*, *Pinacotrypa elegans*, *Spirorbis arkonensis*, *Streblotrypa hamiltonensis*, *Striatopora linnacana*, *Stromatopora mammillata*, *Stromatoporella granulata*, *Syringopora nobilis*, *Taeniopora exigua* and *Trachypora elegantula*.

Nicholson's *Stromatoporella nulliporoides* might have been included in the foregoing list. But this species, having been identified with *S. incrustans*, described by Hall and Whitfield from Iowa, the former name, being the later of the two, gives way to the other. *Pinacotrypa elegans* (Rominger) is plainly identical with *P. serrulata* (Hall), and *P. proporoides* (Nicholson) is probably the same as *P. plana* (Hall), Hall's names being superseded by Rominger's and Nicholson's. Nicholson's *Ortonia intermedia* is also apparently identical with Grabau's *Cornulites hamiltoniae* and must stand in the place of the latter. The proper generic name, however, would seem to be *Cornulites*. *Leiorhynchus laura* (Billings) is the same as *L. multicosta* Hall and has priority over the latter.

Whiteaves was the first to point out that *Hederella filiformis* (Nicholson) is not the same as Billings's *Aulopora filiformis*, and he gives a drawing of Billings's type specimen showing the latter to be truly an *Aulopora*. The writer collected a single fine specimen at Thedford which corresponds exactly with Whiteaves's drawing, and appears to be identical with specimens of *Aulopora iowaensis* Hall and Whitfield, previously collected at Hackberry, Ia. If this identification is correct the latter name has priority over Billings's; and *Hederella filiformis* must be credited to Nicholson and not to Billings.

Specimens of *Favosites clausus*, both from Thedford and Bethany, show a tendency to laminar expansion and the species may be merely a variety of *F. placenta*. It is a question whether *Cystiphyllum corrugatum* Hall, from Bethany, is not identical with *C. vesiculosum* Goldf., noted by Nicholson from Thedford.

There were collected at Bethany three species, at least, which were originally described from Iowa. These are *Stromatopora expansa*, *Stromatoporella incrustans* and *Lioclema occidens*. The latter is not known to have been hitherto reported from New York. It is an abundant species at Hackberry, Ia., Callaway County, Mo., and Milwaukee. A number of solid forms, apparently of this species, were collected at Bethany. Other interesting examples of species originally described from western localities are *Astraeospongia hamiltonensis* and *Intrapora putcolata*, of each of which a beautiful example was obtained.

The crinoid above referred to most nearly resembles *Thylacocrinus clarkei* Wachsmuth and Springer, but differs from the illustration given of that species in this, that the apices of the angles of the polygonal plates have a truncated appearance, or rather the appearance of having been pushed inward by some sharp instrument which has perforated the calyx at the points of juncture of the plates. This Bethany species cannot be very rare, for the writer has another specimen of the same kind which was collected at Canadaigua Lake.

Several hundred specimens belonging to the genus *Fistulipora* and related genera were collected and much time has been spent in their study and determination. The works consulted are Hall and Simpson's volume on the New York *Bryozoa*, Ulrich's work on the *Bryozoa* of Illinois, Nickles and Bassler's Synopsis of American Fossil *Bryozoa*, Nicholson's Reports on the Paleontology of Ontario, and papers by Nicholson in the Annals and Magazine of Natural History and by Rominger in the Transactions of the Philadelphia Academy of Sciences. With such a quantity of good material it was not anticipated that there would be much dif-

faculty in determining the species. Having in mind the beautiful illustrations in Hall and Simpson's great work, and the number of trained paleontologists who had been over the same ground and given the results of their labors in the description of a large number of distinct species, the writer started in on the work of identification with a cheerful confidence which was all too soon overthrown. The elaborate descriptions and elegant drawings, which seem so plain on their face, give no idea of the astonishing variations and obscurities presented by the specimens themselves. Quite a number of the species collected have certainly never been described; and among the others there are such variations in size and shape of apertures, height and obliquity of peristomes, as well as in the plainness of vesicular openings, appearance of maculae and monticules and character of inter-apertural surface generally, that the labor, in spite of its fascination, has been unexpectedly great. Hall and Simpson's diagnoses show the artificiality of their distinction between the genera *Lichenalia* and *Fistulipora* and this is further emphasized by the confusion into which they themselves have sometimes fallen, as shown in cross-references in which a species is sometimes referred to one genus and sometimes to the other. The distinction which they make, based upon the presence or absence of superficial openings of the interapertural vesicles, cannot be maintained. But Ulrich's distinction between *Fistulipora* and *Pinacotrypa*, depending upon the presence in the latter of tubular mesopores in the place of the vesicular structure of the former, is not entirely free from the charge of arbitrariness, as there seem to be all degrees of gradation between these two types. Nickles and Bassler, the latest authorities, show a noticeable lack of confidence in deciding between the two genera. In addition to all these difficulties it is clear that Hall and Simpson have not examined Rominger's and Nicholson's types and have added to the confusion by the unnecessary introduction of synonyms. Even the genera *Pinacotrypa* and *Lioclema* do not always show a clear line of separation, although they have been placed in different families and even different suborders. The divergence between such forms as *Pinacotrypa scrobiculata*, *P. unilinea*, *P. hemispherica*, *Lioclema spheroides*, *L. confertiporum* and *L. segregatum*, seems like a very gradual one and would indicate a tolerably close relationship.

Certain groups of species are clearly distinguishable, among them the following:

Pinacotrypa operculata-stellata-umbilicata-vario-pora; *P. elegans-plana-proporoides-scrobiculata-serrulata*; *Fistulipora trifaria-vesiculata*; *F. colliculata-cultellata-longimacula-triangularis*;

a larger aggregation including *F. constricta-cornuta-criensis-interaspera-ramosa-spinulifera-utriculus* and others; and the group of species included under the genus *Lioclema*. Many of the specimens fall easily into their places under some of these specific names; but a large number exhibit variations which make it difficult to do more than to assign them to one or another of these groups and even throw doubt upon the validity of some of the specific distinctions. The same individual may exhibit upon different portions of its surface differences which have been given specific values. The specimens identified with *Pinacotrypa bullata* agree with the description of that species in every respect except in their manner of growth, having a solid zoarium, with cells opening on all sides. Three entirely distinct forms, with very oblique openings, have with some hesitation been identified as *Fistulipora foliacea*, *F. huronensis* and *F. imbricella*—the hesitation somewhat increased by Nickles and Bassler's declaration that the last named species is unrecognizable.

In respect to the genus *Lioclema* the authorities last named suggest a doubt as to the validity of the numerous distinctions recognized by Hall and Simpson. This doubt does not always seem to be entirely justified. It is not difficult to distinguish quite a number of the forms described, though it may, perhaps, be a question whether they ought to be designated as species or merely as varieties. Indeed there is a temptation to add to the number a beautiful form, apparently different from any so far described, with excessively small apertures and mesopores, monticules with sterile centers occupied by mesopores, the adjacent apertures streaming off in rows and diminishing in size as they recede from the center, the peristomes both of zooecia and mesopores crowned with minute spines.

There is a difference between the Thedford and Bethany fossils of this group in the preservation of surface characters. Specimens from the former locality frequently have a glazed appearance, with the zooecial apertures and vesicular openings closed by a calcareous deposit.

Among the slender, rod-like forms of *Bryozoa* several examples were collected at Bethany, fragmentary for the most part, and generally only one or two of a kind. The determination of these forms has not always been satisfactory, and is mainly limited to the genera. Many fragments of *Fenestellidae* were also collected, but no attempt has been made to give them names.

In the subjoined list Nickles and Bassler's Synopsis has been followed in respect to the *Bryozoa*, with the exception that species which are by them assigned to *Fistulipora*, with the suggestion

that they may prove to belong to *Pinacotrypa*, have been placed under the latter genus. Schuchert's Synopsis has been followed in the case of the *Brachiopoda*. For the Corals Rominger's work on the Corals of Michigan and Hall's illustrations of Devonian Fossils have been carefully studied. Whiteaves's lists of Thedford fossils have been very helpful and his designations have been adopted in most cases outside of the *Bryozoa* and *Brachiopoda*. Grabau's Monograph on the Fossils of Eighteen-mile Creek has also been consulted. To the authorities already named should be added Billings's series of papers on the devonian fossils of Canada West, published in the Canadian Journal in 1859 and 1860. For the opportunity to examine these valuable and not easily obtainable papers the writer is indebted to the kindness of Rev. Hector Currie, of Thedford, Ontario.

List of Fossils from Bethany, N. Y.

PORIFERA.

Astraeospongia hamiltonensis Meek and Worthen.

COELENTERATA.

Alveolites goldfussi Billings.
Aulopora serpens Goldfuss.
A. one or two additional species.
Blothrophyllum conatum (Hall).
Cladopora fischeri (Billings).
C. roemerii (Billings).
C. species.
Crepidophyllum archiaci (Billings).
C. subcaespitosum (Nicholson).
Cyathophyllum gradatum Hall.
C. houghtoni Rominger.
C. nanum Hall.
C. nepos Hall.
C. robustum Hall.
Cystiphyllum americanum Edwards and Haime.
C. conifolle Hall.
C. corrugatum Hall.
C. varians Hall.
Favosites arbuscula Hall.
F. argus Hall.
F. billingsi Rominger.
F. clausus Rominger.

- F. emmonsi Rominger.
F. epidermatus Rominger.
F. hemisphericus Yandell and Shumard.
F. placenta Rominger.
F. tuberosus Rominger.
F. *species*.
Heliophyllum halli Edwards and Haime.
H. juvene (Rominger).
H. proliferum Hall.
H. reflexum Hall.
Michelinia stylopora (Eaton).
M. dividua Hall.
Monilopora antiqua Whiteaves.
Streptelasma rectum Hall.
S. ungula Hall.
Striatopora linnaeana Billings.
Stromatopora mammillata Nicholson.
Stromatoporella expansa (Hall and Whitfield).
S. granulata (Nicholson).
S. incrustans (Hall and Whitfield).
S. *species*.
Syringopora nobilis Billings.
S. *species*.
Trachypora elegantula Billings.
T. limbata (Eaton).
Zaphrentis ampla Hall.
Z. exigua (Billings).
Z. halli Edwards and Haime.
Z. simplex Hall.

ECHINODERMATA.

- Pentremitidea *species*.
Thylacocrinus *species*.
Undetermined plate of Crinoid.

VERMES.

- Autodetus lindstroemi Clarke.
Cornulites intermedius (Nicholson).
Spirorbis angulatus Hall.
S. arkonensis Nicholson.

MOLLUSCOIDEA—BRYOZOA.

- Acanthoclema sulcatum Hall and Simpson.
Ascodictyon fusiforme Nicholson and Etheridge, Jr.

- A. stellatum Nicholson and Etheridge, Jr.
Bactropora *species*.
Botryllopora socialis Nicholson.
Ceramella scidacea Hall.
Clonopora *species*.
Cystodictya incisurata (Hall).
C. tumulosa (Hall and Simpson).
Favicella tessellata (Hall and Simpson).
Fistulipora colliculata (Hall).
F. constricta (Hall).
F. cornuta (Hall and Simpson).
F. distensa (Hall).
F. eriensis Rominger.
F. foliacea (Hall).
F. huronensis (Nicholson).
F. imbricella (Hall).
F. interaspera Hall and Simpson.
F. subtrigona (Hall and Simpson).
F. triangularis (Hall).
F. trifaria Hall and Simpson.
F. vesiculata (Hall and Simpson).
F. a number of undetermined *species*.
Hederella canadensis (Nicholson).
H. cirrhosa Hall.
H. conferta (Hall).
H. filiformis (Nicholson).
H. magna Hall.
Heterotrypa barrandei (Nicholson).
H. moniliformis (Nicholson).
H. *species*.
Intrapora puteolata Hall.
Leptotrypa quadrangularis (Nicholson).
Lioclema decipiens (Hall).
L. digitatum (Hall).
L. involvens (Hall and Simpson).
L. minutum (Rominger).
L. multaculeatum (Hall).
L. occidens (Hall and Whitfield).
L. segregatum (Hall).
L. *species*.
Orthopora bispinulata (Hall).
O. subquadrata (Hall).
O. *species*.
Pinacotrypa bullata? (Hall and Simpson).

- P. elegans* (Rominger).
- P. hemispherica* (Hall).
- P. operculata* (Hall and Simpson).
- P. proporoides* (Nicholson).
- P. pustulosa* (Hall and Simpson).
- P. scrobiculata* (Hall).
- P. stellata* (Hall).
- P. umbilicata* (Hall).
- P. unilinea* (Hall and Simpson).
- P. variopora* (Hall).
- Ptilopora species*.
- Streblotrypa hamiltonensis* (Nicholson).
- Taeniopora exigua* Nicholson.

MOLLUSCOIDEA—BRACHIOPODA.

- Ambocoelia umbonata* (Conrad).
- Athyris spiriferoides* (Eaton).
- Atrypa reticularis* (Linnaeus).
- Camarotoechia billingsi* (Hall).
- C. horsfordi* (Hall).
- C. sappho* (Hall).
- C. thedfordensis* Whiteaves.
- Chonetes coronatus* (Conrad).
- C. lepidus* Hall.
- C. scitulus* Hall.
- C. vicinus* (Castelnau).
- Cranaena romingeri* (Hall).
- Crania crenistriata* Hall.
- Craniella hamiltoniae* (Hall).
- Cryptonella planirostris* Hall.
- C. rectirostris* Hall.
- Cyclorhina nobilis* (Hall).
- Cyrtina hamiltonensis* Hall.
- C. hamiltonensis recta* Hall.
- Delthyris consobrina* (D'Orbigny).
- D. sculptilis* Hall.
- Eunella lincklaeni* (Hall).
- Leiorhynchus laura* (Billings).
- Lingula delia* Hall.
- L. ligea* Hall.
- Martinia subumbona* (Hall).
- Meristella barrisi* Hall.
- M. haskinsi* Hall.
- M. species*.

Nucleospira concinna Hall.
Orthothetes chemungensis (Conrad).
Parazyga hirsuta (Hall).
Pentamerella pavilionensis (Hall).
Pholidops hamiltoniae Hall.
Pholidostrophia iowaensis (Owen).
Productella spinulicosta Hall.
Reticularia fimbriata (Conrad).
Rhipidomella idonea (Hall).
R. leucosia (Hall).
R. penelope (Hall).
R. vanuxemi (Hall).
Spirifer audaculus (Conrad).
S. audaculus macronotus Hall.
S. divaricatus Hall.
S. granulosus (Conrad).
S. marcyi Hall.
S. pennatus (Atwater)= S. mucronatus (Conrad).
S. tullius Hall.
Stropheodonta concava Hall.
S. demissa (Conrad).
S. inaequistriata (Conrad).
S. perplana (Conrad).
S. *species*.
Trematospira gibbosa Hall.
Tropidoleptus carinatus (Conrad).
Vitulina pustulosa Hall.

MOLLUSCA—GASTROPODA.

Loxonema *species*.
Platyceras bucculentum Hall.
P. carinatum Hall.
P. dumosum rarispinum Hall.
P. symmetricum Hall.
P. thetis Hall.
P. *species*.
Platyostoma lineatum Conrad.
P. turbinatum Hall.
P. unisulcatum Conrad.

MOLLUSCA—CEPHALOPODA.

Goniatites uniangularis Conrad.
Orthoceras subulatum Hall.

MOLLUSCA—PTEROPODA.

Conularia undulata? Hall.

Hyolithes species.

CRUSTACEA.

Beyrichia species.

Phacops rana (Green).

Strepula species.

Notes on the Winter Habits of the Red-Headed Woodpecker.

H. A. WINKENWERDER.

The red-headed woodpecker is ordinarily a migrant. Its winter range in the Mississippi Valley, according to Prof. W. W. Cooke, is much restricted, although it is abundant as far north as the bottom lands of southern Illinois (1). He feeds upon both animal and vegetable matter in nearly equal quantities, the percentage varying according to season and locality. In the spring its food consists mostly of insects. "In the fall," says Capt. Chas. Bendire, "its diet is more largely vegetable, one of its staples being beechnuts; the berries of sour gum, dog wood, and palmetto are also largely eaten; acorns and Indian corn and small grain are likewise used, and it is well known that these birds store away supplies, consisting both of insects and vegetable matter, for winter use (2).

A remarkable case of the storing of insects is the one reported by Dr. G. S. Agersburg of Vermillion, S. Dakota, and it is probably he who was the first to report this habit of storing. He writes as follows:

"Last spring in opening a good many birds of this species with the object of ascertaining their principal food, I found in their stomachs nothing but young grasshoppers. One of them, which had its headquarters near my house, was observed making frequent visits to an old oak post, and on examining it I found a large crack where the woodpecker had inserted about 100 grasshoppers of all sizes (for future use, as later observation proved), which were put in without killing them, but they were so firmly wedged in the crack that they in vain tried to get free. I told this to a couple of farmers, and found that they had also seen the same thing, and showed me posts which were used for the same purpose. Later in the season the woodpecker whose station was near my house commenced to use his stores, and today (February 10) there are only a few shriveled-up grasshoppers left" (3).

Dr. C. Hart Merriam has noted many cases of the red-head wintering far to the north of its winter home when the food supply was abundant. From his extended observations he has drawn

(1) W. W. Cooke. *Migration in the Miss. Valley*, U. S. Agr. Rep. 1888, page 130.

(2) Capt. C. A. Bendire, *Life Histories of N. A. Birds*, p. 108, vol. II.

(3) Bull. Nutt. Ornith. Club, pp. 194, 195, from *Beal Food of Woodpeckers*, U. S. Dept. of Agr. Bull. No. 7, Div. Ornith. and Mammalogy.

the conclusion that a good year for beechnuts means a good year for red-heads and squirrels. He found them wintering as far north as Connecticut and the northeastern portions of New York.

In November 1899, Dr. O. G. Libby called my attention to the fact that red-heads were storing acorns in the vicinity of Madison, Wis., by inserting them between the cork ridges of our larger oaks (*Quercus*). Investigation soon showed that these birds were busy with this task in nearly every oak grove about Madison. Before winter had fairly set in a great many trees were well stocked with acorns, some containing hundreds of them. They were also found below the loose bark on old trees, in cracks in fences, in old posts, and in decayed wood. From a fence post which was split across the top and hollowed out I removed more than a pint of the nuts. Whenever the whole nut could be placed in a crevice conveniently this was done, but where the crevice was too narrow they were split in halves. This was very often the case. Nowhere, however, did I find them still in the cup.

Thinking the birds might have stored these acorns for the grubs they would yield I examined a large number, but no grubs were found. The half acorns, too, were in good condition, apparently as well preserved as the others.

Close watch was kept up all winter. One grove just west of the city seemed a favorable spot for the birds, and since it is only a short distance from the street railway line offered a convenient place for observation. It lies upon the western slope of a considerable hill (University Heights), and contains about two acres of healthy oaks (mostly *Quercus alba* and *coccinea*) interspersed with a few dead trees.

This place was visited about once every week for the entire winter. On bright sunny days the cries and rappings of these birds could be heard for some distance around. They flew about chasing each other as if engaged in play; sometimes as many as four or five occupied the same tree scolding in most excited tones; then again they could be seen hopping up and down the tree trunk, stopping now and then to rap upon the wood as if they enjoyed the drumming sound. Thus they would turn from one diversion to another, cheery and apparently well contented with the way nature treated them. But in severe weather they were not so lively. When the weather was intensely cold, although they were stirring, the jubilant spirit was absent. They made very little noise, and kept close to the tree trunks. I visited the place several times during stormy weather and then it was rare to see or even hear a single specimen. From the excretions in and about several holes in trees I concluded that these were the places they used for shelter during inclement weather, as

also during the night, although I failed to drive out any by pounding these trees with a heavy club.

As the winter wore on the store of food gradually disappeared, until the end of February, when it was about exhausted. At this time, too, the birds began to scatter, the number in the grove decreased, and they were soon heard tapping upon the telephone posts about town. But many of the trees still bore evidences of the services they rendered during the past winter. In most cases the pulpy matter had been eaten out of the acorns without removing them, leaving a hollow shell as a mark in the corky bark of the tree. When they were not so firmly secured the remains were generally found in coarse, but more often finely broken parts at the base of the tree.

Upon further investigation by means of printed inquiries sent throughout the state, the red-headed woodpecker was reported from all but the extreme northern portions. The results as a whole were surprising. Of the one hundred and fifty blanks that were mailed about one hundred were returned, and the majority of these were intelligently answered. Still the greatest care must be exercised in the use of these reports. Such cases as seemed doubtful were either corroborated or discarded. Thus some of the reports from the northern tier of counties proved to have reference to the piliated woodpecker (*Ceophloeus*). In such cases where the birds were reported as present, but not the acorns, I have assumed that either the acorns were overlooked, or, as is the case in some reports, they came from localities where *Quercus* is scarce. All cases in which both the birds and acorns were reported were regarded as correct, but where only the acorns were reported considerable care is necessary. Thus Mr. B. H. Smith of Rock county writes that he saw blue jays storing the acorns; Mr. J. P. Lewis of Friendship, Adams county, says he saw the blue jay eat them; and Mr. Herbert Vaughn of Bowers, Walworth county, reports that the nuts were stored by the large spotted woodpecker (*Dryobates villosus*, in all probability).

With these facts and doubts before the reader he will be able to take the following results for what they are worth.

Many of the reports were exceptionally good and showed that much interest is taken in our Wisconsin birds. The results obtained should give us a fair conception of the distribution of *Melanerpes* in our state during the winter of 1899-1900. As the accompanying tabulation will readily show, the distribution seems to have been confined to certain areas, in some of which they were exceptionally numerous, in others less so. About Madison they were seen in large numbers. So, too, in the neighborhood of Beaver Dam, Dodge county. Mr. W. E. Snyder writes from that

place as follows: "I could show you two dozen *any day* all winter long, *within city limits*," and with reference to stored acorns, "Every tract of woods contains some of them." From Grant county they were reported very numerous, burying the acorns from one to two inches into the body of dead poplars.

In the northern section of the state, north of the 45th parallel, the red-head was comparatively scarce, excepting in Polk county. This, too, is the only place so far north from which stored acorns were reported, which is not at all remarkable, because Polk county is fairly supplied with oak.

From the remainder of the state we may separate the following three areas in which the red-headed woodpecker was abundant during the winter of 1899-1900. One of these lies in the northwestern portion, including Eau Claire, Pierce, Pepin, Clark and Dunn counties; another in the southwestern corner, including Grant, Iowa and La Fayette counties; the third lies fairly within the central portion of the state, including, beside Dane and Dodge counties, those bordering on Waushara. Whether or not this distribution coincides with that of *Quercus* in our state I cannot say. For the detailed distribution I have appended a tabulation of the results of my investigation.

Before concluding I should like to call attention to the biological significance of the storing habit of *Melanerpes*. On the one hand it should show the powers of a migratory species to adapt itself to a cold and wintery climate; on the other, the extreme importance of food over temperature as a cause for migration. These questions, however, must be attacked from the standpoint of the kind of food a bird eats, together with its method of obtaining it. It is just this which enables the red-head and all our resident birds to remain here over winter.

LOCALITY.		Were Red-headed Woodpeckers Seen?	Number of Birds Seen.	Were Acorns Stored.	Date of Report.
TOWN.	COUNTY.				
Ashland.....	Ashland.....	No	.....	No	March 26
Marinette.....	Marinette.....	Yes	2	No	March 26
W. Denmark.....	Polk.....	Yes	4 or 5	Yes	March 31
Washburn.....	Bayfield.....	Yes	2	No	April 2
Merrill.....	Lincoln.....	No	.....	No	March 26
Bailey's Harbor.....	Door.....	Yes	2	No	March 12
Egg Harbor.....	Door.....	No	.....	No	Feb. 22
Forestville.....	Door.....	No	.....	No	Feb. 21
Hammond.....	St. Croix.....	Yes	1	No	March 17
Woodville.....	St. Croix.....	No	.....	No	Feb. 17
Menomonee.....	Dunn.....	Yes	2	No	March 7
Red Cedar.....	Dunn.....	Yes	5 or 6	No	Feb. 26
Wausau.....	Marathon.....	No	.....	No	March 5
Ringle.....	Marathon.....	Yes	1	No	Feb. 26
Kelley Brook.....	Oconto.....	No	.....	No	March 14
Shawano.....	Shawano.....	No	.....	No	April 7
Shiocton.....	Outagamie.....	No	.....	No	March 12
Appleton.....	Outagamie.....	No	.....	No	March 10
Amherst.....	Portage.....	No	.....	No	March 5
Grand Rapids.....	Wood.....	No	.....	No	March 5
Grand Rapids.....	Wood.....	No	.....	No	March 14
Rudolph.....	Wood.....	No	.....	Yes	Feb. 20
Durand.....	Pepin.....	No	.....	No	Feb. 17
Durand.....	Pepin.....	Yes	Few	Yes	March 21
Pepin.....	Pepin.....	Yes	8 or 10	No	March 19
Arkansaw.....	Pepin.....	No	.....	No	March 23
Augusta.....	Eau Clair.....	Yes	6	Yes	March 11
Augusta.....	Eau Clair.....	Yes	6	No	March 12
Thorp.....	Clark.....	Yes	2	Yes	Feb. 20
Eidwold.....	Clark.....	Yes	.....	Yes	Feb. 24
Winneconne.....	Winnebago.....	No	.....	No	March 12
Pickett.....	Winnebago.....	Yes	5	Yes	March 16
Omro.....	Winnebago.....	No	.....	No	March 8
Monroe.....	Green.....	No	.....	No	March 19
Alma.....	Buffalo.....	No	.....	No	March 21
Nelson.....	Buffalo.....	No	.....	No	March 19
Waldo.....	Sheboygan.....	Yes	10	No	March 12
Elkhart.....	Sheboygan.....	No	.....	No	March 11
West Salem.....	La Crosse.....	No	.....	No	Feb. 24
Sparta.....	Monroe.....	No	.....	No	March 7
Friendship.....	Adams.....	Yes	1	Yes	March 12
Manchester.....	Green Lake.....	Yes	8 or 10	No	March 5
Kingston.....	Green Lake.....	Yes	6	No	March 6
Necedah.....	Juneau.....	No	.....	No	March 10
Forest Jct.....	Calumet.....	No	.....	No	March 12
Liberty Bluff.....	Marquette.....	Yes	30	Yes	March 5
Packwaukeee.....	Marquette.....	Yes	2	No	March 6

Four Mile.....	Fond du Lac.....	No	.....	No	Feb. 20
Strum.....	Trempeleau.....	Yes	3 or 4	No	March 7
Galesville.....	Trempeleau.....	Yes	12	No	March 12
River Falls.....	Pierce.....	Yes	4	No	April 15
River Falls.....	Pierce.....	Yes	1	Yes	April 23
Algoma.....	Kewaunee.....	No	.....	No	Feb. 23
Kodan.....	Kewaunee.....	No	.....	No	Feb. 20
Nero.....	Manitowoc.....	No	.....	Yes	March 5
East Gibson.....	Manitowoc.....	Yes	20	No	Feb. 20
Waupaca.....	Waupaca.....	Yes	200?	Yes	March 6
Marcellon.....	Columbia.....	No	.....	No	March 6
Delton.....	Sauk.....	Yes	6	No	March 10
Wilmot.....	Kenosha.....	No	.....	No	Feb. 15
Evansville.....	Rock.....	No	.....	No	April 2
Tiffany.....	Rock.....	No	.....	Yes	Feb. 6
Burlington.....	Racine.....	Yes	4	No	Feb. 20
Racine.....	Racine.....	No	.....	No	Feb. 19
Benton.....	La Fayette.....	Yes	12	No	March 21
Shullsburg.....	La Fayette.....	No	.....	No	March 24
Lancaster.....	Grant.....	Yes	50	No	March 11
Lancaster.....	Grant.....	Yes	many	Yes	.....
Soldiers Grove.....	Crawford.....	Yes	1	No	March 6
Ft. Atkinson.....	Jefferson.....	No	.....	No	March 5
Watertown.....	Jefferson.....	Yes	2	No	.....
Bowers.....	Walworth.....	No	.....	Yes	March 5
Beaver Dam.....	Dodge.....	Yes	24	Yes	Feb. 26
Fredonia.....	Ozaukee.....	Yes	4	No	Feb. 28
Hillside.....	Iowa.....	Yes	10	Yes	.....
Madison.....	Dane.....	Yes	20	Yes	.....

Place-Modes of *Acris Gryllus* for Madison, Wis.

By P. H. DERNEHL.

The purpose of this paper is to describe the Madison form unit of the cricket frog *Acris gryllus* var. *crepitans* (Le Conte) for comparisons with specimens from other localities and with future determinations of this form unit.

The frogs employed for study in the preparation of this paper were taken October 18, 1901, in Dane county, Wisconsin, along the banks of an artificial lagoon, fed by Lake Mendota, and near the Catfish river.

Along the banks of this artificial stream the frogs were extremely numerous, making it a comparatively small task to secure the one hundred specimens from which my tabulated results were obtained.

The frogs were collected at random.

DESCRIPTION OF THE FORM-UNIT.

The eyes are comparatively large and prominent, their posterior angles being slightly anterior to the angles of the mouth. (See Fig. I.) The snout is extended, and projects beyond the lower lip. (See Fig. I.) From about its middle point the body tapers gradually towards the snout with no contraction for the neck. (See Plate.) The external nares are small and more anterior than the eye, and each is placed upon a slight eminence, the canthus rostralis. The tongue is broadly oval, slightly or not at all notched (See Fig. II.); individuals having their tongue not notched predominating in numbers. It is free for about one-fourth or a little less of its length from behind, and is also free at the sides.

The tympanum is very small, in some individuals barely noticeable.

The inner nares are decidedly larger than the external nares.

The vomerine teeth are situated in two oval patches slightly larger than the internal nares, and are placed between these, their slightly longer axis inclined to each other posteriorly. Their posterior borders are in about the same transverse line with those of the inner nares, and they extend a little beyond anteriorly. (See Fig. II.) In this respect the frogs differed decidedly from the individuals described by Cope, who describes the position of these teeth thus: "The vomerine teeth are situated in two oval patches about the size of the nares, the slightly longer axis inclined a little

to each other backward. They are placed between the nares, their anterior edges nearly in the same transverse line with those of the nares and extending a little beyond the nares posteriorly." It will be noted that the position of the vomerines is remarkably anterior as compared with other of our small American hyloids.

The openings of the Eustachian tubes are very minute.

The gular fold is well developed.

Quantitative data were taken for a number of characteristics selected either because (1) they were apparently variable here, or (2) known to vary throughout its range, these characteristics being known to me because given as diagnostic between the two subspecies into which the northern and southern forms have been grouped.

METHODS.

The measurements were taken in m. m. in most cases, but in one-half and one-tenth m. m. in the smaller measurements.

The measurements were recorded as falling into the classes 4-4.99 m. m., etc., or 4-4.09, etc., as the case might be. These measurements were then converted into per cent of total lengths by means of Zimmerman's Calculating Tables. The middle value of the two classes concerned being used as 24.5 divided by 28.5. The percentages were grouped in the same way as the original measurements. In some cases, where certain fractions not involving the total length had been used by systematists in describing this species or its subspecies, these percentages were also determined and seriated.

Where the resulting polygons were irregular owing to the use of too many classes for the number of individuals, they were grouped into larger classes, as few as possible being brought together to make the new classes. Of the several possible limits those were chosen which approached most nearly the theoretical curve, the sex and total length being known for each measurement. The extreme classes of each polygon were examined to find if any correlation existed between sex or age and any of the characteristics examined. This confessedly crude method revealed none except between sex and length.

MEASUREMENTS.

Length.—I found the length to vary from 20 m. m. to 30 m. m., the mode being 25-26 m. m. The dotted lines in polygon A represent the polygon for males, from which it is seen that the males are shorter than the females.

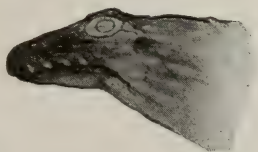


FIG. I



FIG. II

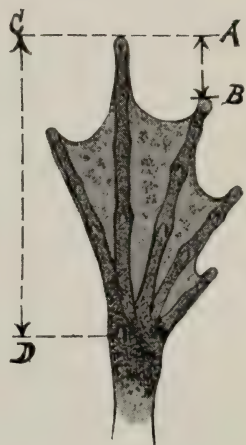
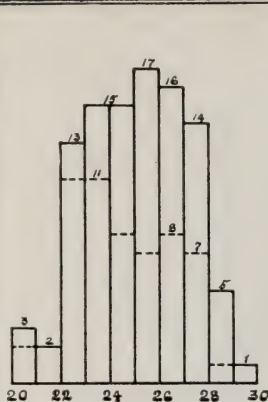
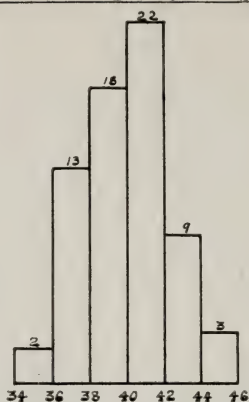


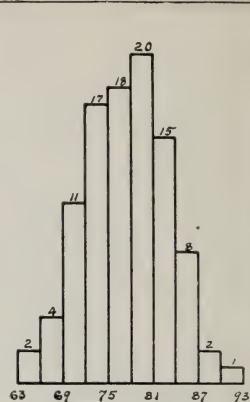
FIG. III



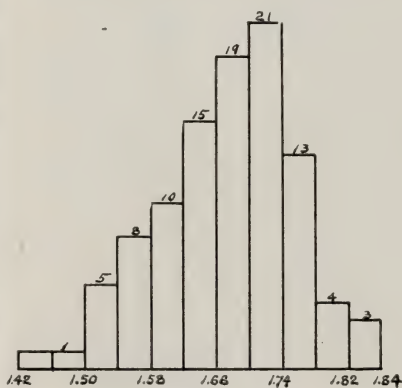
POLYGON-A. TOTAL LENGTH



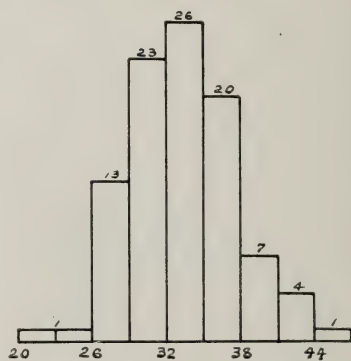
POLYGON-B. HEAD LENGTH



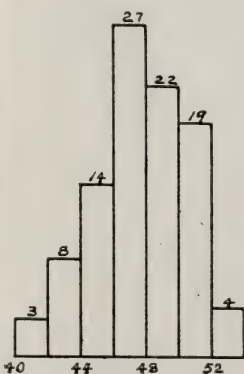
POLYGON-C. HEAD BREADTH



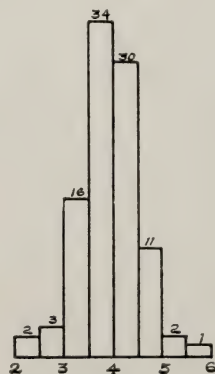
POLYGON-D. LEG LENGTH



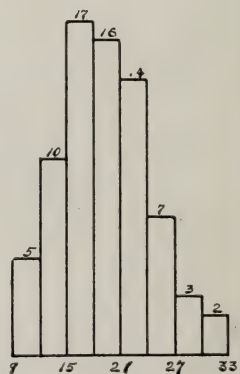
POLYGON-E. TOE FOOT



POLYGON-F. FOOT LENGTH OF LEG



POLYGON-G. ABSOLUTE TOE



POLYGON-H. TUBEROSITY

The head, measured from the gular fold to tip of snout, varied from 8 m. m. to 11.7 m. m.; reduced to per cent of total length the mode became 40 per cent to 42 per cent, with a range from 34 per cent to 46 per cent. (See Poly. B.)

The breadth of head was measured across posterior edge of the tympanums and was seriated in terms of head length and varied from 6.2 m. m. to 8.8 m. m., and gave the mode of 78 per cent to 81 per cent, with a range from 63 per cent to 93 per cent. (See Poly. C.)

The leg was measured from the granule beneath the vent to the tip of farthest projecting toe. It varied in length from 30 m. m. to 51 m. m. Divided by the total length the mode became 1.70 to 1.74, with a range of from 1.42 to 1.84. (See Poly. D.)

The tibia is longer than the femur, and the femur somewhat longer than the foot.

The foot is well developed. All the metatarsi are cleft to the base excepting the two outer ones which are united. The toes are webbed to the base of the disks, the membrane filling up most the space between them except on each side of the longest metatarsi where the membrane forms a narrow margin on the penultimate joint. On the exterior edge of the foot the membrane continues as a rudimentary one. (See Fig. III.) Beneath the articulations of the metatarsi are two large metatarsal tubercles, on the outer side of the tarsus are three or four well developed subarticular tubercles. The foot was measured and seriated in terms of leg length, from the large metatarsal tubercle to the tip of the longest toe. (See Fig. III. C-D.), and was found to vary from 8 m. m. to 14 m. m., thus giving a range from 40 per cent to 54 per cent, with a mode of 46 per cent to 48 per cent. (See Poly. F.)

The projection of the second toe beyond the third (See Fig. III a-b), was found to vary from 2 m. m. to 5 m. m., with a range from 1.5 per cent to 6 per cent, giving a mode of 35 per cent to 40 per cent. (See Poly. G.) It was also seriated in terms of length of foot and varied from 20 per cent to 47 per cent, with a mode of 32 per cent to 35 per cent. (See Poly. E.)

The hands, like the feet, are well developed, though without webs. The fingers are provided with slightly enlarged convex disks, thus enabling the creatures to climb upon smooth perpendicular surfaces. The disks are traversed by a slight groove. The inner finger is caudal to the rest, and is provided with a soft and prominent tubercle at its base. Separated from this tubercle by a narrow interval is another tubercle of about equal size.

COLOR.

The color of this species is extremely variable. Usually the upper surface has a ground color of ashy gray with a faint greenish hue or brown. The whole upper surface of body and limbs is more or less overrun with small scattered elongate or rounded warts of irregular size. The back is covered with a varying number of black spots, all generally margined with lighter. Between the eyes is a triangle nearly equilateral, its sides slightly concave, and its base connecting the edges of the upper eyelids. This triangle is relatively constant and characteristic, though so pale and indistinct in some as to be barely discernible.

The upper jaw is black or dark brown, with four vertical pale lines on each side. From the eye to arm is a pale white line, usually quite easily seen. Dorsal to this line extending nearly to the insertion of the fore leg is an elongate black mark, and beneath the line is another running parallel to the posterior one and extending from the sides of the lower jaw to the lower part of the insertion of the arm. Posterior to the insertion of the arm is a large dark oblique white margined spot on the side of the body. Posterior to this, and more dorsal, is another black spot, also margined with white and running obliquely backward.

The median dorsal part is frequently occupied by a longitudinal red or green band, these bands being frequently bordered on either side by obscure black spots. The green and red bands are, where present, extremely variable from a pale inconspicuous green or red line to a prominent and distinct band of either color. Very rarely are both the green and red color present in the same individual. In the one hundred specimens examined I found but one case. The bands of red or green are either continuous or interrupted. Where very pronounced the band is generally continuous, and when not is generally interrupted. The colors have apparently no correlation with sex or age, as the table will illustrate. The one hundred individuals studied offered thirty-five individuals in which the colored bands were present.

RED			GREEN		
LITTLE	MEDIUM	MUCH	LITTLE	MEDIUM	MUCH
♂ 27 m. m.	♀ 27 m. m.	♀ 25 m. m.	♂ 27 m. m.	♀ 26 m. m.	♂ 25 m. m.
♀ 25 m. m.	♂ 25 m. m.	♀ 21 m. m.	♀ 24 m. m.		♂ 23 m. m.
♀ 27 m. m.	♂ 22 m. m.	♂ 27 m. m.	♀ 24 m. m.		♀ 28 m. m.
♂ 23 m. m.		♂ 23 m. m.	♀ 24 m. m.		♀ 23 m. m.
♂ 24 m. m.		♂ 24 m. m.	♂ 26 m. m.		♂ 27 m. m.
♀ 26 m. m.		♂ 24 m. m.	♂ 27 m. m.		
♀ 25 m. m.		♂ 25 m. m.			
♂ 24 m. m.		♂ 24 m. m.			
		♂ 22 m. m.			
		♂ 22 m. m.			
		♂ 23 m. m.			
		♂ 23 m. m.			
8	3	12	6	1	5

Beneath the color is ashy white; at times very pale yellow on the throat. The throat is generally more or less speckled with dusky or brown. (See Plate.)

The lower jaw is pale or exhibits a few dark specks at the symphysis. The ventral surface of the arm shows no black blotches, and the thigh, leg and tarsus are also destitute of black markings ventrally, though posteriorly two or three transverse ones.

A black spot is frequently visible over the vent, and a dark bar either continuous or interrupted passes along the posterior thigh as a femoral stripe.

Tuberosity: As stated, the dorsal part of the frog is more or less covered with warty elevations. Within the dark triangle on the head which was taken as an index for the general tuberosity the elevations varied from 9 to 32 (excluding one of fifty), with a mode of 15-18. (Poly. H.)

The lower parts are covered by depressed granulations extending half way up the side, and on the inferior face of the thigh. Two large granules are conspicuous beneath the vent.

Color Changes: The rapid color changes attributed to these frogs by various authors as Dr. Hay, Cope and Le Conte were not observed in individuals which we had in confinement in the laboratory for some time, the only noticeable change being a fading or increase of the ground color, the bands of green or red remaining permanent.

In formalin preservative the color fades into a dark ashy gray, the green bands disappear and assume the normal ground color, or can be distinguished as a darker band. The red bands do not undergo this change, or only to a slight degree, in either case, however, the bright luster of the living animal is entirely lost.

SUMMARY AND CONCLUSIONS.

I. The form unit of *Acris gryllus* v. *crepitans* for Madison, Wisconsin, has been described.

II. Quantitative determinations from one hundred individuals have been made of a number of characters and seriated.

III. The variation of color of the back and of the number of tuberosities has been found to be very great.

IV. The males are smaller than the females.

PLACE-MODES.

The determination of place-modes has for its object the investigation of evolution by exact quantitative methods. It results in fixing the conditions of a species in a particular locality at a particular time, thus giving a basis upon which to determine any change which that same species may undergo in the same locality after a definite lapse of time. The changes which a species may undergo in a relatively small number of years under ordinary conditions of environment are not sufficient to be detected in cases where descriptions are qualitative only or based upon a few individuals, but where a large number of individuals, taken at random, are measured the modes may be used as standards for reference.

Aided by such determinations, we can know the rate and direction of any change which a species may undergo, so that we may draw more definite conclusions concerning the causes of specific change. The comparison of place-modes throughout the range of the species has yielded important results. To quote Dr. C. B. Davenport: "The establishments of these place-modes for various species in various localities is the first *sure* step towards the solution of the problem of the Origin of Species."

Work of this nature is suggested for those who desire to make actual contributions to our knowledge of botany or zoology and yet lack the facilities or knowledge necessary for original contributions to the structure or relations of species.

The following classes seem especially favorable for study because of size, variability, ease of collecting, and, in many cases, of the presence of serial structures, which may be counted—reptiles, batrachians, fishes, decapods and myriapods. In plants the flowers and leaves offer numerous opportunities.

This work was undertaken in response to the appeal of Dr. C. B. Davenport for the quantitative study of variable species for the purpose of throwing light on the origin of species. I would call attention of the members of naturalists' field clubs to the articles by Dr. Davenport in the bibliography. This work is

particularly adapted to these clubs in our large cities. The valuable enthusiasm of many young naturalists in these clubs is being satisfied by the almost useless task of searching for new stations for rare species.

In conclusion I wish to express my thanks to Mr. R. H. Johnson, to whom I owe the interest which stimulated me to the preparation of this paper and by whose kind advice and assistance the work was greatly facilitated.

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The Paddle Fish (Polyodon Spathula).

By HORACE BEACH, Sr.

This fish attracted my attention some forty years since on account of its odd and unusual form. Barton W. Everman, United States Ichthyologist, writes me that "this species was first named by Walbaum in 1792, *Squalus spathula*; later in 1801 Bloch and Schneider called it *Polyodon folium*, thinking it was a new species, but as the fish of Bloch and Schneider and that of Walbaum are specifically identical and as Walbaum's is the older name it must be accepted for the species. The fish is not a *Squalus* as thought by Walbaum, but belongs to the genus *Polyodon*, the correct Latin name is *Polyodon spathula* and not *Polyodon folium*, as you see in some books.

The *Polyodon spathula* belongs to the family of Polyodontidae, and "is found in the Mississippi and the Ohio, and their tributaries, in Lake Erie and in southern waters." It is a naked cartilaginous fish, its skin in color and appearance somewhat resembling the catfish. Its common name in different localities is paddle fish, spoonbill cat, shovel-nosed sturgeon, etc. It is edible, its flesh being white and savory. The fishermen cut off the head and tail and sell it for "boneless cat." Everman informs me that the roe makes good cavier. The mature fish is from 4 to 5 feet in length. I have seen them over 4 feet. Jacob Scrogum, a reliable fisherman, told me that he once caught one that was 5 feet in length. The smallest caught are from 10 to 12 inches in length and have an abundance of sharp needle like teeth, whereas the mature fish is toothless. This would seem to indicate that the small fish have a different method of obtaining their food from the mature fish. It has a heterocercal tail, a symmetrical body from the tail to the head, which seems abnormally large, a toothless mouth capable of opening very wide, a slender under jaw, and very long gill-covers extending backward from the gill openings over the smooth naked skin, and capable of being closed water tight. It has ample gill-rakes, small eyes located well forward and low down, and two blow holes located back of the junction of the paddle. The paddle or spatula is a little more than one-fourth the whole length of the fish. It is composed of a beautiful network of cartilaginous bones which are covered with a stout skin. The fish subsists in part if not wholly on confervae, consisting of a tubular water plant which grows in great abundance on or near the surface of the water. I have formed a theory as to the manner in which the fish manages to collect and swallow

its food. This theory is somewhat conjectural but to my mind seems reasonable. The fish elevates its paddle above the water and swims into the water plant, manipulating and guiding the water plant into its mouth; this would cause a current of water containing the food to pass out at the gill openings, while the gill-rakes would catch and hold the food. The eyes are admirably placed to see and control the movements of the fish. After a proper amount of confervae is thus caught the long gill-cover and mouth are closed, a compression of the cavity back of the gill-rakes would force the water forward and out of the blow holes and thus release the water plant from the gill-rakes, and a further compression of the mouth would press out the remaining water and leave the food in a fit condition to be swallowed without an undue amount of water. I once saw this fish swimming with its paddle raised above the surface of the water but had no conception at that time that it was collecting food, in fact did not know what it subsisted upon. Fishermen have told me that they have seen worms in their stomachs mixed with confervae, but I am of the opinion the fish is a vegetarian, as I know they have parasitic worms in their stomachs, of which I will say more later on. I thought if they are vegetarians that they must hibernate in the winter; as there is then no vegetation for them to live upon. Acting upon this impression I visited the fishermen drawing seines under the ice. I opened the stomachs of a number of the fishes. The walls of the stomachs were thick and contracted, the cavity was very small and in no instance was there found a particle of food in them, only a little yellowish fluid and sometimes a lively knot of parasitic worms that seemed greatly disturbed at being exposed to the cold atmosphere. This fish while lying in the muddy bottom in a torpid state during the winter is often attacked by lampreys, sometimes having life literally sucked out of them or so nearly so as not to have vitality enough to recuperate when released from their icy prison. I have seen many of them lying on the shores in the spring with their bodies emaciated and covered by wounds made by the lampreys. I have often seen these fish after the water became warm jump out of the water and come down on their sides with a splash, probably to rid themselves of lampreys. There is one very remarkable fact that no one has ever seen, a very small fish of this species, at least this is true as far as any information I have been able to obtain. I have a standing offer of \$5.00 to any one who will bring me one not over six inches long, thus far without any response.

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Harlowe, David, E. P. Allis Co., Milwaukee.
Hartwell, Sidney R., 198 Wisconsin St., Milwaukee.
Hollister, O. L., 370 Eighteenth Ave., Milwaukee.
Hinsdale, Dr. H. B., Ann Arbor, Mich.

Jung, Philip, 623 Second St., Milwaukee.
Jaycox, H. M., Lake Mills, Wis.
Johnson, H. J., 452 Fifteenth Ave., Milwaukee.

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Kiewert, Charles L., 9 Waverly Place, Milwaukee.
Koeffler, C. A., Pabst Bldg., Milwaukee.
Kuehne, Rudolph, 825 N. Eighth St., Sheboygan, Wis.

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Lando, J., 419 E. Water St., Milwaukee.
Lutz, Hugo, 1248 Burleigh St., Milwaukee.
Laue, A. F., 1111 Sycamore St., Milwaukee.

Logemann, George, 244 W. Water St., Milwaukee.
Lorenzen, Thomas G., 75 Juneau Ave., Milwaukee.
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Lyman, F. H., 205 Market St., Kenosha, Wis.
Lawson, Publius V., Menasha, Wis.

Mann, C. L., 124 Farwell Ave., Milwaukee.
Meinecke, A., 623 Milwaukee St., Milwaukee.
Munkwitz, Charles, 431 Milwaukee St., Milwaukee.
Miller, B. K., Jr., 300 Marshall St., Milwaukee.
Marks, Dr. S., 136 Wisconsin St., Milwaukee.
Marshall, W. A., Wisconsin Univ., Madison, Wis.
Meinecke, F., A. Meinecke & Sons, Milwaukee.
Monroe, Charles E., Goldsmith Bldg., Milwaukee.
Menger, Dr. R., San Antonio, Texas.
Mitchell, A. S., 220 Greenbush St., Milwaukee.
Mueller, Frank, Princeton, Wis.
Melcher, G. F., Woodland, Wis.
Merrill, Harriet B., Public Museum, Milwaukee.
Mitchell, S. D., Ripon, Wis.

Nehrling, H., 254 Twenty-first St., Milwaukee.

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Ogden, Dr. H. V., Goldsmith Bldg., Milwaukee.

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Pereles, T. J., 535 Astor St., Milwaukee.
Pereles, Herman, 31 Juneau Ave., Milwaukee.
Phillips, George G., care E. P. Allis Co., Milwaukee.
Porter, R. L., Mukwonago, Wis.
Peet, Rev. S. D., Chicago, Ill.

Reeder, John, Calumet, Mich.
Rauterberg, F., Public Museum, Milwaukee.
Reuss, G., 668 Sixth St., Milwaukee.
Roemheld, H., 1280 Eleventh St., Milwaukee.
Rohde, Paul C., 523 Walnut St., Milwaukee.
Ruenzel, Henry G., 753 Third St., Milwaukee.
Raasch, Richard, 2431 Brown St., Milwaukee.
Robinson, Dr. W. B., 2324 State St., Milwaukee.
Riley, Will W., Mack Block, care Fed. Life, Milwaukee.

- Slocum, A. W., Field Col. Museum, Chicago, Ill.
Stanhope, Dr. Charles D., 2718 State St., Milwaukee.
Sherman, Dr. L., 448 Jackson St., Milwaukee.
Stark, Joshua, 355 Farwell Ave., Milwaukee.
Schoenebeck, A. T., Spruce, Wis.
Schoenebeck, Carl, Lena, Wis.
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Steinmeyer, Mrs. Marg., 2427 Grand Ave., Milwaukee.
Sheridan, J. A., Germania Bldg., Milwaukee.
Shroeder, A., care Empire Fur. Co., Milwaukee.
Slocum, Dr. Charles E., Defiance, Ohio.
Schuette, Geo. H., Manitowoc, Wis.
Snyder, W. E., Beaver Dam, Wis.
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- Uehlein, August, 332 Galena St., Milwaukee.
- Vogel, F., Jr., 583 Cass St., Milwaukee.
Voss, Edw. E., 140 Fifteenth St., Milwaukee.
Vogel, W. H., Seventh and Sycamore Sts., Milwaukee.
- Winkler, F. C., 131 Eleventh St., Milwaukee.
Wanvig, R. O., 315 Eighteenth Ave., Milwaukee.
Whitney, Lee R., Room 225, P. O. Bldg., Milwaukee.
Wells, Philip, 374 Twenty-fourth St., Milwaukee.
West, George A., 2828 Highland Blvd., Milwaukee.
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Wood, C. E., Mukwonago, Wis.
Willard, H. A., Mazomanie, Wis.
Wadmond, S. C., 1034 Washington Ave., Racine, Wis.
Winkenwerder, H. A., 217 Murray St., Madison, Wis.
- Zimmermann, O. B., Univ. of Wisconsin, Madison, Wis.

BULLETIN

OF THE

WISCONSIN NATURAL HISTORY SOCIETY

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MILWAUKEE, WISCONSIN.

The Wisconsin Natural History Society,

MILWAUKEE, WIS.

ORGANIZED MAY 6, 1857.

OFFICERS.

EDGAR E. TELLER—PRESIDENT 3303 Cedar Street, Milwaukee
DR. S. GRAENICHER—VICE PRES'T . . 551 Seventh Street, Milwaukee
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Numismatics . . . W. F. Sandrock	Entomology C. E. Brown
Botany E. Bruncken	Mineralogy Louis Lotz

REGULAR MEETINGS.

(1) These are all held in the Society's lecture room in the Museum-Library Bldg., Milwaukee.

(2) Meetings of the combined sections take place on the 2nd Thursday of each Month, at 8 P. M.

(3) The Archeology and Numismatics sections meet on the 3rd Thursday of each Month.

(4) General Meetings are on the last Thursday of each Month except July and August.

(5) Meetings of the Archeologists and collectors of the State are to be held semi-annually under the direction of the Archeology section, for the purpose of furthering the cause of Wisconsin Archeology.

PUBLICATIONS.

(1) The "Bulletin of the Wisconsin Natural History Society"—a 64 page octavo publication issued quarterly. Editor, W. J. Bennetts.

(2) The "Wisconsin Archeologist," published by the Archeology section. Editor, C. E. Brown.

MEMBERSHIP DUES.

City Members, \$3.00 per annum; Non-resident Members, \$1.00 per annum;
Life Members, one payment of fifty dollars.

BULLETIN

OF THE

WISCONSIN NATURAL HISTORY SOCIETY.

Vol. 2, New Series.

APRIL, 1902.

No. 2.

Proceedings of the Wisconsin Natural History Society.

November 27, 1901, to February 27, 1902.

THURSDAY, NOV. 27, 1901.

The general meeting for November was held this day in the lecture room of the public museum. Twenty-eight persons were present and President Teller occupied the chair.

C. E. Brown read reports of 2 regular section meetings held earlier in the month and also of a meeting of the numismatic section held at the residence of Mr. Louis Lotz.

A communication from the Misses Lapham of Oconomowoc was then brought to the attention of those present, in which they offered to present to the society 2 natural history scrap-books compiled about 40 years ago, by their father, Dr. Increase A. Lapham. On the motion of E. Bruncken the books were accepted, and the secretary instructed to convey the thanks of the society to the Misses Lapham.

The following were then elected to membership: John T. Reeder of Calumet, Mich., and Alison S. Grover of South Milwaukee. Rev. S. D. Peet of Chicago, and John G. Gregory of Milwaukee, were elected honorary members.

A paper on the "Distribution and Succession of Forest Trees in the vicinity of Milwaukee" was then read by Ernest Bruncken, Dr. S. Graenicher following with a paper entitled "Notes on some Species of Wasps occurring at the End of the Season." A paper on "The Winter Habits of the Red Headed Woodpecker," by H. A. Winkenwerder of Madison was read by the secretary.

THURSDAY, DEC. 26, 1901.

This meeting was held in the usual place with 31 persons present and Mr. Teller presiding.

The minutes of 2 section meetings were read by C. E. Brown, after which 8 new members were admitted into the society as follows: H. A. Winkenwerder, W. E. Snyder, H. A. Crosby, M. C. Long, E. Butts, Fisk H. Day, E. C. Perkins, and F. M. Benedict.

A paper by Horace Beach, Sr., of Prairie du Chien on the paddle fish *Polyodon spathula* was read by the secretary. The author stated that the fish was a vegetable feeder, living on confervae and other plant growths of the waters it frequented, and lying dormant in the mud at the bottom during the winter months.

This paper was followed by one by Adolf Biersach, who described the experiences of himself and companions during a collecting trip made into Nicaragua, C. A., during the early part of 1901. Mounted specimens of birds and animals met with during the trip were exhibited to illustrate the paper.

Rev. Stephen D. Peet of Chicago, who was present, then made a short address, briefly outlining the work he had done in investigating the mound systems of Wisconsin. He exhibited charts of several groups of mounds and gave his interpretation of their purpose and significance.

THURSDAY, JAN. 30, 1902.

This meeting was held in the usual place with 63 persons present.

After the usual reports of meetings had been read the following were elected to membership: J. M. S. McDonald, Oscar Buxbaum, G. P. Stickney, S. W. Faville, W. F. Crosby, L. S. Drew, D. Mc L. Miller, Hon. G. W. Wolf, John Gerend, and Charles Goessl, Miss Mary J. Lapham and Miss Julia A. Lapham were elected honorary members.

Prof. E. C. Case then began the lecture of the evening, which was entitled "Methods of Collecting, Preserving and Restoring the Remains of large extinct Vertebrates."

The principal feature of the lecture was the large number of excellent lantern illustrations accompanying it, many of them being from photographs taken by Mr. Case himself. The localities where such collecting was chiefly done were shown to be among the most desolate and barren ones on the continent, such as the Bad Lands of South Dakota, and the chalk deserts of Kansas. The methods of fitting out an expedition and of taking care of the fossil parts discovered were described, as also was

the work of cleaning and mounting the parts after their arrival at the museum. The latter part of the lecture was devoted to the work that has been done in restoring and picturing these extinct animals as they appeared while living on this continent, many thousands of years ago.

THURSDAY, FEB. 27, 1902.

At this meeting C. E. Brown reported on 2 section meetings held respectively on the 13th and 20th of the month, and gave notice that there would be a meeting of the numismatic section on the evening of March 6.

Dr. G. W. Peckham, chairman of the library committee, then read the following proposition which the committee had laid before the executive board of the Public Museum:

Dec. 12, 1901.

To the Executive Committee of the Board of Trustees of the Public Museum:

GENTLEMEN—At a meeting of the Wisconsin Natural History Society held last month the society authorized the special committee to suggest the following terms upon which they would be willing to transfer to the Public Museum the collection of books and pamphlets now in the possession of the society as well as others that might come into its possession in the future.

1st. That the Museum utilize the publications of the society as a means for maintaining as far as practicable unbroken sets of the publications of the various scientific societies.

2d. That as far as possible, the gaps in the present sets be filled in.

3d. That they provide for the suitable cataloguing of the present collection and future additions to the same.

4th. That they make the library accessible to the members of the Natural History Society at such hours as the Museum may be open.

5th. That upon the order of the President or the Secretary of the Natural History Society the Museum loan to the members of the society papers or books belonging to the sets provided for in the above recommendations.

Very truly,

GEO. W. PECKHAM,

Chairman.

To this he stated the following answer had been received:

Dec. 19, 1901.

Dr. Geo. W. Peckham, Chairman Committee of Wisconsin Natural History Society.

DEAR SIR:—In response to your communication of December 12, in relation to the terms upon which the Wisconsin Natural History Society would be willing to transfer their books to the Public Museum, I wish to say that the propositions contained in your communication have been considered by the Board of Trustees, that they have been accepted and that they shall be complied with as soon as the Board of Trustees will be in position to make the proper arrangements.

Yours truly,

CARL THAL,

Acting Secretary.

A report of progress was then read from Carl Thal, acting secretary of the Museum, who stated that as a result of their efforts to fill the gaps in the sets of the North American Scientific societies, 100 volumes and 525 pamphlets had been added to the library during the past 5 months.

C. E. Brown drew attention to the unsatisfactory and incomplete state of the by-laws of the society, and G. W. Peckham, E. Bruncken and Charles Doerflinger were appointed a committee for their revision.

The following were elected to membership: W. H. Elkey, Clara Gladys Jones, Richard Philipp, Carl Thal, John F. Fedlin, C. H. Kroeger, F. Krempel, Theo. Wiese, A. H. Lohman, Mrs. Charles H. Kartak.

Miss Harriet B. Merrill then read an interesting paper entitled "The Scientific Spirit." It was shown in detail how science and its methods dominate in nearly all domains of knowledge and civilized life. Literature, however, it was said, was an exception to the rule, as the personal element contained in it prevented our measuring it by the absolute standards of science.

Mr. W. E. Snyder of Beaver Dam, Wis., followed with a paper on the "Mammals of Dodge County, Wisconsin," mentioning 36 species and sub-species that had all—with 2 exceptions—come under his observation. A large collection of skins which Mr. Snyder had brought with him to illustrate his paper, and which represented all but the larger animals in his list, was examined with much interest by those present at the close of the meeting.

The attendance on this occasion was 29.

WILLIAM J. BENNETTS,

Recording Secretary.

Some Recent Observations on the Migration of Birds.

By H. A. WINKENWERDER.

(Preliminary Report).

The following paper is designed merely as a report of progress. During the fall of 1897 Dr. O. G. Libby called the attention of the writer to the excellent facilities the telescope offers for the study of bird migration, and during the summer of 1899 upon his advice the following work was undertaken. Although it was originally intended that the course of investigation should comprise several series of telescopic observations and such material as could be obtained from a season's observation at one of the largest lighthouses on our Great Lakes, the work has broadened considerably since then. Since much of value in the study of bird migration depends upon the migratory routes followed in these spring and fall flights, some little attention has been paid to this subject. Also the history of the study of migration, as well as discussions upon the origin and causes of these semi-annual journeys, have been included in this work. These phases of the subject are about completed, but it will be impracticable to treat them in this article.

It was intended that the entire work should be completed with the present writing, but, owing to the quantity of material collected and the pressure of other work, this has become impossible. Hence the present paper is merely a preliminary report, designed to call attention to the progress of the work and the methods of procedure.

Although two visits were made to Spectacle Reef lighthouse, near Mackinac, Mich.,* the weather proved unfavorable for the collection of data from this source both times.

TELESCOPIC OBSERVATIONS.

Telescopic observations were begun at the Washburn Observatory at Madison, Wisconsin, in the fall of 1899, but the real work did not commence until the spring of 1900. During the months of April and May of that year five good sets of observations were obtained. In the fall of the same year one set was obtained October 8. During the spring of 1900 interested persons from several of our western universities were asked to co-operate in the collection of data, and the result was excellent. The following

*The writer spent two weeks at Spectacle Reef during the falls of 1899 and 1900.

directions were sent to all who expressed their willingness to assist:

BIRD MIGRATION.

Directions for Observing with Telescope.

The Instrument.

Should be one with an objective ranging somewhere between 2 and 6 inches. The eye-piece should be supplied with 2, or if possible 4, hair-lines crossing in the center, thus dividing the field of vision into quadrants or octants.

Time of Observation.

Begin to observe as soon as the moon is high enough to come distinctly into the field of vision, and continue until morning.

To Begin the Observations.

Focus the telescope on the moon with the point of intersection of the hair-lines on the moon's center. Turn the eye-piece so that one of the lines lies parallel to the direction in which the moon is moving across the heaven. Now turn to your note paper. At the head of this write the date, locality, direction of wind, and weather in general. Just below this draw a circle, putting in the hair-lines as they appear through the telescope. Number them, beginning at the right hand side of the one you have placed parallel to the direction of the moon and continuing counter clock-wise. See figure below:

The Observations.

(It is a difficult task to observe and write out the observations at the same time, and, also, it will tire the eyes to look at the bright moon too long at one stretch. It is, therefore, advisable to have two observers so as to relieve each other every half hour or even every fifteen minutes, the one writing the observations while the other is observing).

The time should be divided into periods of fifteen minutes each, i. e. the observations should be made for periods of this length.

The following data should be noted with every bird that crosses the field of vision:

The number and approximate tenths (as indicated by the hair-lines) at which the bird enters and likewise at which it leaves the field of vision.

The speed at which it is flying—slow, fast, like a shot, etc., etc.

His approximate size as compared to Goldfinch (size 1), Robin (size 2), and Crow (size 3). If slightly smaller add—sign, if larger a + sign.

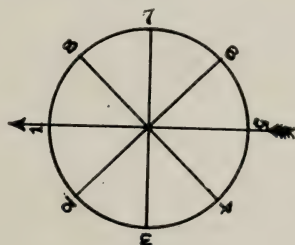
State if the bird is out of focus.

State if its wing-strokes are plainly seen.

Other remarks that you may think of value.

The notes should look like this:

Madison, Wis., May 14, 1900. Warm, with quite strong south-west wind; sky perfectly clear.



Period, 8:15—8:30.

I.	II.	III.	IV.	Remarks.
ir.	out.	Speed.	Size.	
..	...			
4.6	1.2	very slow	2	Small hawk soaring.
3.8	8.1	fast	1	Flight like goldfinch.
3.8	8.1	fast	1	Flight like goldfinch.
5.2	8.8	very fast	1	.....
4.1	8.5	fast	2	Curved below center.

III. and IV. are of less importance than I. and II.

NOTE. If these directions are not clearly understood, or if you wish further information, write.

This resulted in eight excellent sets of data, and much credit is due Mr. Leon J. Cole of Ann Arbor, Faculty University of Michigan; Mr. H. S. Warren of Detroit, Secretary Michigan Ornithological Society; Mr. William James Rice, Faculty Lake Forest University; Mr. O. S. Dart, student University of Minnesota, and Mr. Wegemann, student Beloit College, and their assistants, for their hearty co-operation in the collection of these data. A set consisting of one evening's observations was contributed from each Ann Arbor, Detroit and Minneapolis; from Lake Forest there were two, and the writer, with the assistance of Mr.

Wegemann, obtained three at Beloit, while Dr. Libby conducted the observations at Madison. The data received from Michigan deserve special mention for the care with which they were collected.

One graphic representation illustrating tabulations of these data has been completed and will appear below. It is hoped that the other comparative tabulations will bring out points in the migration of birds hitherto unknown. Beside the observations mentioned above, Dr. Libby has recently turned over to the writer nine sets of data taken at Madison from April 9, 1898, to May 22, 1899, and three tabulations of data taken at Madison in the fall of 1897. This makes a total of 28 sets of data, comprising the observation of over fifteen hundred individual birds. Since these data were collected at various times during four years and in different localities they should yield good results.

It may appear to the inexperienced reader that little more than the direction of flight, the speed and size of a bird can be distinguished by this method. There are, however, many features brought out with the help of the telescope, which, although of little value when taken separately, reveal many points of interest when brought together in the form of tabulation. Furthermore, it is not of rare occurrence that a species can be identified.

The following tabulation will show in general something of what these data may yield:

BIRD MIGRATION AT DETROIT.

Being situated on a wide river between Lake Erie and Lake Huron, Detroit should offer good facilities for the study of migration. The following excellent summary of the observations taken at that place, together with the original data, was submitted by Mr. H. S. Warren:

Data on Nocturnal Bird Migration.

OBSERVATIONS TAKEN WITH THE TELESCOPE, WITH THE MOON FOR A FIELD OF VISION.

Detroit, Mich., May 13, 1900.

Meteorological Data: Atmosphere, fair; wind, light, southwest. Temperature: Max. 70 degrees at 8 p. m.; min. 66 degrees at 12 midnight.

Time, 8:15 p. m. to 12 midnight, divided into periods of 15 minutes each.

Number of birds seen from	8:15 to 8:30,	8.	
"	8:30 to 8:45,	7	
"	8:45 to 9:00,	10.	
"	9:00 to 9:15,	8.	First hour, 33
		—	
"	9:15 to 9:30,	9.	
"	9:30 to 9:45,	10.	
"	9:45 to 10:00,	14.	
"	10:00 to 10:15,	8.	Second h'r. 41
		—	
"	10:15 to 10:30,	10.	
"	10:30 to 10:45,	6.	
"	10:45 to 11:00,	4.	
"	11:00 to 11:15,	7.	Third h'r., 27
		—	
"	11:15 to 11:30,	4.	
"	11:30 to 11:45,	1.	
"	11:45 to 12:00,	5.	4th period, 10
		—	

Total number seen from 8:15 to 12:00, 111.

DIRECTIONS OF FLIGHT.

Number of birds traveling Northeast.....	74
Number of birds traveling North-northeast.....	13
Number of birds traveling East-northeast.....	11
Number of birds traveling North.....	4
Number of birds traveling North-northwest.....	5
Number of birds traveling Northwest.....	3
Number of birds traveling Southeast.....	1

SPEED.

Number of birds traveling very rapidly.....	75
Number of birds traveling moderately.....	22
Number of birds traveling slowly	12
Number of birds traveling very slowly.....	2

RELATIVE SIZES OF BIRDS.

Small (Goldfinch)	66
Medium (Robin)	27
Large (Crow)	15
Very large	3

IDENTIFICATIONS, ETC.

No. 12 (see original list) had the flight of a hawk or owl. No. 28 had wings spread like a hawk soaring. No. 31, wing motions were plainly seen, but no identification could be made on account of uncertain distance. No. 34 had wavy motion of flight, like goldfinch. No. 46 passed slowly, the wings beat rapidly and the neck was seen stretched out like a duck, loon, or grebe. The slow passage was evidently caused by distance. No. 61 had flight like goldfinch. No. 72, wing motions were plainly seen. No. 94 passed very slowly; this was evidently a large bird at long range, as it occupied three seconds in passing over the field and wing motions were plainly seen.

COURSES OF FLIGHT.

108 Birds kept their direct courses while passing over the field of vision.

- 1 Bird came in moving southeast and curved back to northeast, changing its course about 45 deg.
- 2 Birds flew in a curve; one changing its course from northeast to east and one from northeast to north.

The observations were taken at the Cartwright observatory located about three-fifths of a mile from the river. The telescope, a 6-inch refracting instrument, equatorially mounted, with an 8-inch focus, was at an average angle, during the period of observation, of about thirty degrees. If the birds that were traveling northeast, which numbered considerably more than half of all noted, were following the course of the Detroit River, which seemed evident, they must have been somewhat more than half a mile above the surface.

BIRD MIGRATION AT BELOIT AND MADISON.

The tabulations given below represent several periods of the original data from Beloit and Madison. They will serve to show a few of the points gained directly from observation. The telescope offers a means for watching nocturnal migrants during the time they are actually moving. Though we gain a view of only an infinitesimal portion of the vast migratory wave in so small a field of vision, enough is revealed to make it well worth the undertaking.

DATA FROM BELOIT.
BELOIT, Wis., May 12, 1900.

Period, 1:45—2:00.		Speed.	Size.	Remarks.
In.	Out.			
...	...		.	
2.3	4.4	swift	1	.....
1.6	4.9	swift	2	.....
1.3	4.8	swift	2	same birds, rapidly
1.3	4.7	swift	2	succeeding each other.
1.	5.6	swift	2	.....
8.	5.7		1+	.....
8.9	6.		1+	.....
2.3	5.4			.....
2.8	4.8			.....
2.	5.8	swift	2*—	.....
2.	5.5			.....
1.9	5.6			.....
1.5	5.6			.....
1.8	4.8			.....
8.8	5.8			.....
8.8	5.5		1	.....
...	...			Birds are coming in bunches.
...	...			
...	...			First bunch—Same birds, all fly-
...	...			ing about parallel to the line
...	...			from 8.8—5.5, several in field at
...	...			same time. Came too rapidly to
...	...			note exact direction.
...	...			Second bunch.
...	...			
...	...			
1.8	5.8		2*—	.....
2.	5.8			.....
3.	8.3		1—	.....
1.2	6.3		2*—	.....
2.1	4.3	slow	2	.....
1.2	6.		1	.....
1.8	5.8		2	.....
3.	6.3	swift		.....
2.8	5.8		2	.....
1.6	5.8			.....

Total number of Birds, 35.

*Looked like same species.

DATA FROM MADISON.

MADISON, WIS., Apr. 18, 1900.

Period, 12:15—12:30.

In.	Out.	Speed.	Size.	Remarks.
...	...		.	
3.5	8.9	swift		Flew like a shot.
3.8	8.2			.....
3.	8.9		3*	.....
5.7	7.9			.....
4.2	7.9			Out of focus.
...	...			Pause of five minutes of no birds.
...	...		..	
3.8	8.3	slow	1—	.....
4.9	7.2	fast	3+	Out of focus.
5.8	7.1			Flight of goldfinch.
5.	2.1			.....
4.2	8.2			.....
5.	1.2			.....
7.9	4.2			Sailed out of the field like a meadow lark.
4.	8.6	swift	1	.....
3.9	8.5	slow	1	Flitting carelessly. He paused a second as if to turn in his course.

.....
Total number of birds, 14.

CARTOGRAPHIC REPRESENTATIONS.

The cartographic representations into which the majority, if not all, of the data for this work will be placed are of two kinds. The first (See Plate I.) represents a graphic view illustrating the number of birds seen in periods of fifteen minutes each. Upon the assumption that the majority of nocturnal migrants commence their journey at about the hour of sundown, the eight sets of observations upon the accompanying plate were reduced to the same time after that hour. The data from which these graphs were drawn were collected from six different localities. It was hoped that they could all be obtained upon the same day, but this was high impossible.

It is remarkable to note the similarity in the rise and fall of some of these graphs, especially in the cases of Ann Arbor and Detroit. From the Madison and Beloit lines it would seem that

PLATE I.

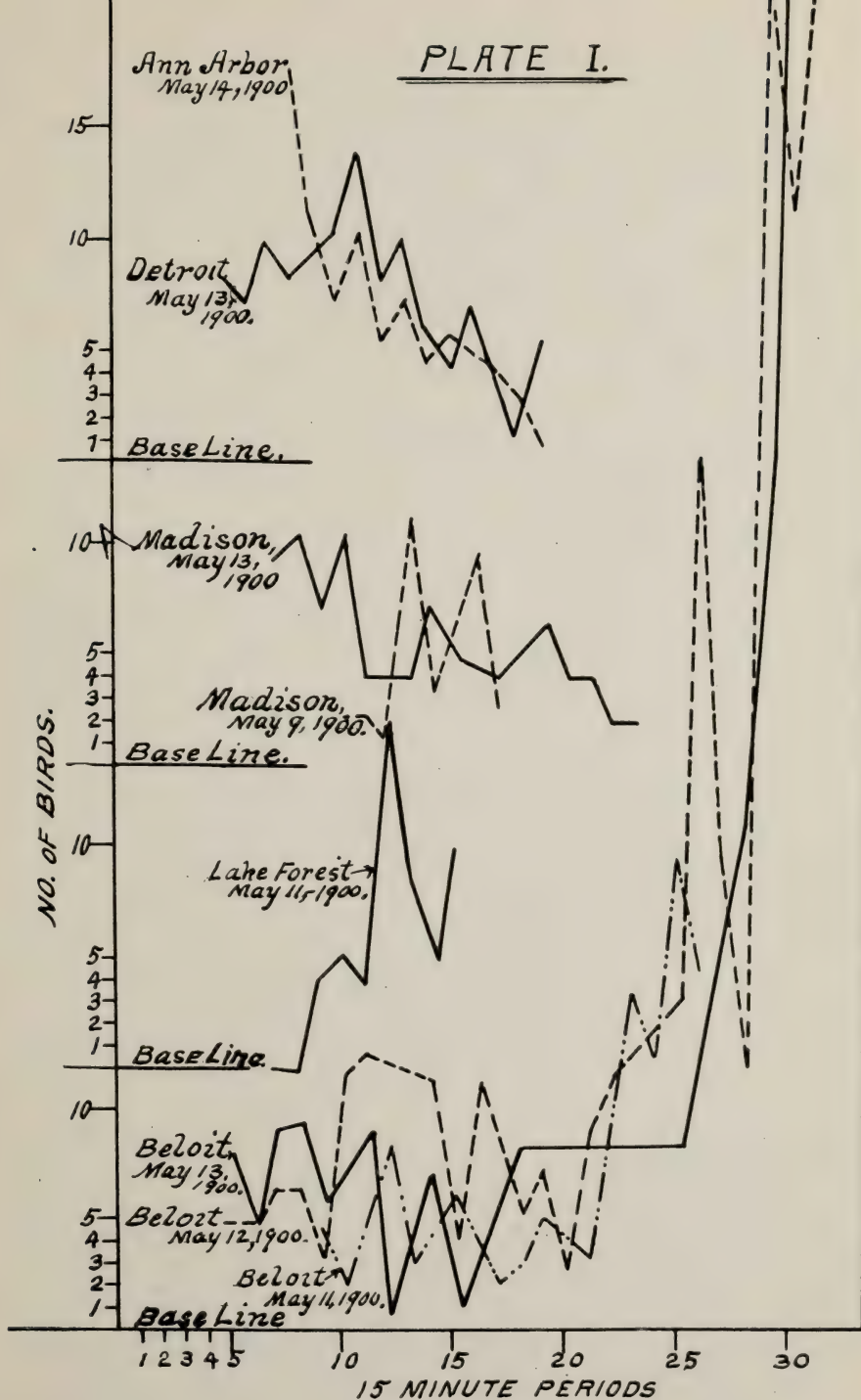
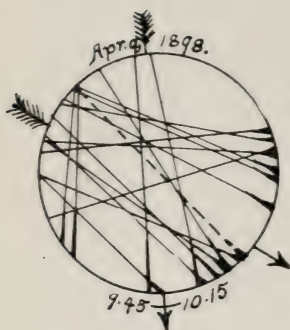
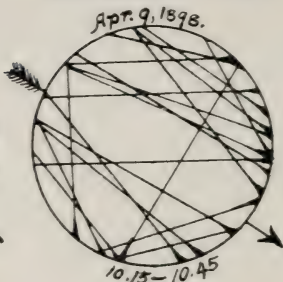


PLATE II.

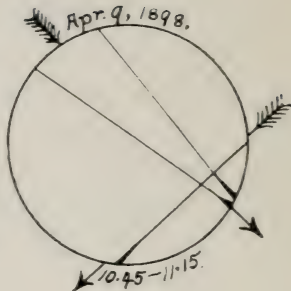
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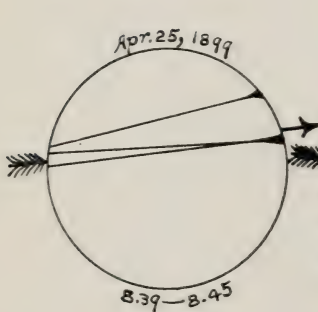
Apr. 9, 1898.



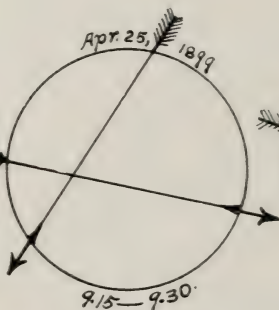
Apr. 9, 1898.



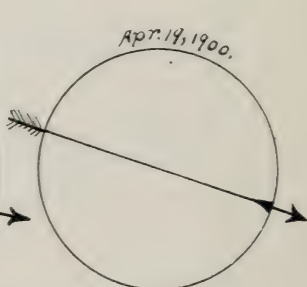
Apr. 25, 1899



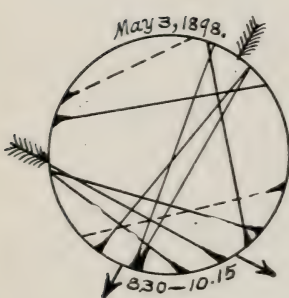
Apr. 25, 1899



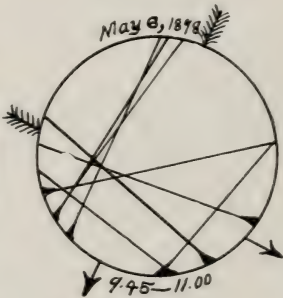
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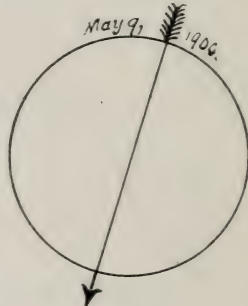
May 3, 1898.



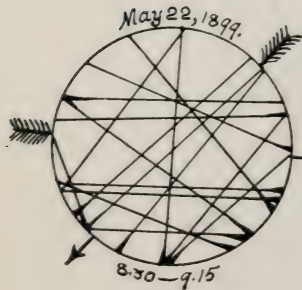
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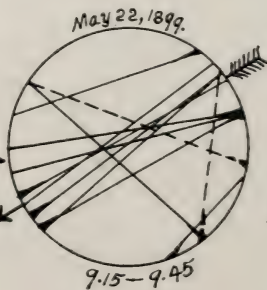
May 9, 1900.



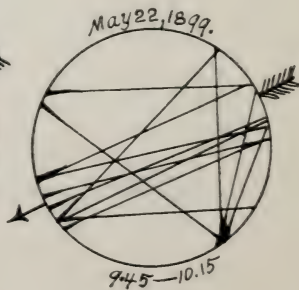
May 22, 1899.



May 22, 1899.



May 22, 1899.



the topography of the surrounding country has much influence upon the number of birds flying. In each of the Beloit lines the sudden enormous rise of the lines marks the time when the telescope pointed directly down the course of the Rock River. In Madison the same feature is true. During four years of observation the greatest flights were obtained when the telescope pointed over the Madison Lakes and Yahara River system. The topography surrounding Lake Forest, Ann Arbor and Detroit, has not yet been studied sufficiently to enable us to say what the conditions are at these places.

Another form into which the observations will be placed is that illustrated by Plate II. We have here a number of circles each representing the field of vision during a certain period of time. Each line in the circle represents the flight of a bird, the lightly shaded end shows the place of entrance into the field of vision, the other the exit, and the dotted lines birds that were so close to the telescope that they appeared out of focus. The arrows outside of the circles show the general direction of flight for the period. This makes a most serviceable form into which to place these data.

One special feature noticeable on the accompanying plate (II.) is the two main directions of flight, with the predominance of the one in April and the other in May. This would seem to indicate two distinct migratory routes passing through Madison. Indeed other observations seem to indicate that this is actually the case.

It is not the object of this preliminary report to discuss generalizations. The foregoing considerations have been given merely to show the trend of the work and something of the results we may expect to attain from this method of observation. The telescope certainly offers an excellent field for research to the student of ornithology, and it is to be hoped that in the near future it may be brought into operation over a larger territory.

Brief Notes on Some of the Rarer Birds of Dodge Co., Wis.

By **W. E. SNYDER**, Beaver Dam, Wis.

It is not claimed by the author that the birds enumerated below are rare birds throughout the state—the list referring only to this county. To my knowledge some of these occur in considerable numbers elsewhere in Wisconsin. My observations date from Oct. 12, 1888.

LARUS PHILADELPHIA-BONAPART'S GULL.—A male was taken on the lake here in October, 1893, and 5 birds were brought to me the past fall—when they were quite common, in small flocks.

LARUS FRANKLINI—FRANKLIN'S ROSY GULL.—Two specimens—(Nos. 4526 and 4527, coll. of W. E. Snyder)—both taken on Sept. 18, 1901. They were in company and none others have been seen or taken to my knowledge. One was an ad ♀ with bright rosy plumage (No. 4526), the other an immature ♂.

STERNA TCHEGRAVA-CASPIAN TERN.—Two records—one taken Oct. 4, 1896—too badly decomposed when it came into my hands to sex or preserve—and one taken Oct. 5, 1900 (No. 3236, coll. of W. E. S.)

ANHINGA ANHINGA-ANHINGA.—Mr. Chatfield shot one here some 20 years ago. He described his bird to me and says he knows the Cormorant (*P. dilpohus*), and I am satisfied of its identity.

CLANGULA HYEMALIS—OLD SQUAW.—Five records—two taken at Fox Lake on Oct. 29, 1898; two taken there on Nov. 1, 1898, and I mounted one shot at the same place on Nov. 5, 1899. The first four were not sexed—as they were in the hands of a Milwaukee gunner who would not part with them—yet they were all ♀♀ or perhaps some immature ♂♂. They lacked the long tail feathers and black breasts of the adult. The fifth (No. 1853) proved on discussion to be a ♀.

ARDEA EGRETТА—AMERICAN EGRET.—Mr. George A. Morrison, once a taxidermist at Fox Lake, but now residing in Colorado, reports the capture of one at Randolph in May, 1895. It was mounted by Mr. Morrison. I did not see the bird, but presume the identification was correctly made, as Mr. Morrison was a painstaking student of birds.

PHALAROPUS LOBATUS—NORTHERN PHALAROPE.—Three were secured by Mr. Morrison and the writer at Fox Lake on Sept. 4, 1891. Two more were seen there the next day. These are my only records.

MICROPALAMA HIMANTOPUS—STILT SANDPIPER.—But one record a juv ♂ secured by me on this lake on Sept. 13, 1890. In an evil moment I disposed of it to a California collector, thinking I would be able to obtain more of them. Efforts to regain possession of the bird have proved futile.

TRINGA (PELIDNA) A-PACIFICA—RED-BACKED SANDPIPER.—Three records of capture—two on Oct. 4, 1901 (4578 and 4579) and one on Oct. 25, 1901 (No. 4653).

LIMOSA FEDOA—MARBLED GODWIT.—I have seen one of the two birds taken here some 20 years ago by Mr. Chatfield and verified his identity.

ECTOPISTES MIGRATORIUS—PASSENGER PIGEON.—Only two actual records of capture in 13 years—though I have seen them on several occasions—but not since about 1896. The last one taken was a juvenile, found dead on Downer College Campus at Fox Lake, by a Miss Brown, on Sept. 11, 1891.

ARENARIA MORINELLUS—TURNSTONE.—First and only record one seen by me on Aug. 18, 1901. It was in a high state of plumage.

COLINUS VIRGINIANUS—BOBWHITE.—Becoming more common each year. Flocks may be found at any time in certain localities. Hunters, spare the quail—as the sight of a few recalls days when they were common here.

CATHARTES AURA—TURKEY VULTURE.—Now and then seen. I have handled but two—one taken on May 18, 1894—an ad ♂—and one taken Oct. 1, 1899—ad ♀. The former was poor in flesh, with great scabs on its feet—evidently a diseased bird.

BUTEO LINEATUS—RED-SHOULDERED HAWK.—But one taken—an immature ♂, shot by me on Sept. 15, 1900 (No. 3195, coll. W. E. S.)

STRIX PRATICOLA—AMERICAN BARN OWL.—One taken at Fox Lake in the winter of 1894 (Morrison) and Mr. W. R. Chatfield of this city took one here “many years ago.” Mr. Chatfield was once a taxidermist and is a student of birds as well.

MELANERPES CAROLINUS—RED-BELLIED WOODPECKER.—Three records—one seen June 5, 1899; one Oct. 26, 1901, and one Nov.

16, 1901. The markings of this bird and their peculiar notes render their identity certain.

NUTTALORNIS (CONTOPUS) BOREALIS—OLIVE-SIDED FLY-CATCHER.—Three records—a ♂ taken Aug. 12, 1896 (No. 209, coll. of W. E. S.), a ♀ taken September 15, 1901 (No. 4459, coll. of W. E. S.) and one seen on Sept. 11, 1901.

COCCOTHRAUSTES VESPERTINUS—EVENING GROSBEAK.—Occurs commonly some winters, feeding on the seeds of the box elder tree. None observed as yet this present winter.

PINACOLA ENUCLEATOR—PINE GROSBEAK.—Has occurred a few winters. One ♀ was taken near Loss Lake by Geo. J. Miller on Jan. 16, 1900. It was feeding *on the ground* in company with a large flock of Snowflakes (*Passerina nivalis*) on the edge of a tamarack swamp. It was the only one seen.

SPINUS PINUS—PINE SISKIN.—Erratic. Abundant from Sept. 25 to Dec. 30, 1896. Next seen the past fall—when it was common.

AMMODRAMUS HENSLOWI—HENSLOW'S SPARROW.—This bird is an abundant summer resident in the dryer marshes about Beaver Dam. Early morn and after sunset are its hours of song if song it can be called.

SPIZELLA PALLIDA—CLAY-COLORED SPARROW.—One record—a bird taken July 9, 1899 (No. 1430, coll. of W. E. S.)

ZONOTRICHIA QUERULA—HARRIS' SPARROW.—One record—a ♂ of the year, taken on Oct. 5, 1890. It was in company with a flock of Fox Sparrows (*P. iliaca*).

ZONOTRICHIA LEUCOPHRYS—WHITE-CROWNED SPARROW.—One was seen about eight miles southwest of Beaver Dam in the fall of 1896 (Exact date not accessible at this moment). It is my only record.

MELOSPIZA LINCOLNI—LINCOLN'S SPARROW.—Was quite common in the spring migrations of 1892 and at least two pairs bred. But not seen again until the past season—when a few were seen—and one taken on Sept. 16 (No. 4476, coll. of W. E. S.).

AMPELIS GARRULUS—BOHEMIAN WAXWING.—Common nearly every winter. None seen thus far the present season.

VIREO SOLITARIUS—SOLITARY OR BLUE HEADED VIREO.—But one record—one captured on Sept. 24, 1901 (No. 4536, coll. of W. E. S.)

VIREO PHILADELPHICUS—PHILADELPHIA VIREO.—Two records—one seen in the spring of 1901 and one taken on Sept. 26, 1901 (No. 4561, coll. of W. E. S.).

HELMINTHOPHILA CHRYSOPTERA—GOLDEN-WINGED WARBLER.—Two records—a bird taken Aug. 14, 1901 (No. 4245) and one taken Sept. 10, 1901 (No. 4405).

DENDROICA CAERULEA—CERULEAN WARBLER.—One seen by me some 10 years ago, but have never seen it since.

HELMINTHOPHILA RUBRICAPILLA—NASHVILLE WARBLER.—I have long looked for this bird, but have so far taken but one—on Sept. 8, 1901 (No. 4399).

GEOTHLYPIS AGILIS—CONNECTICUT WARBLER.—First record—May 24, 1901 (No. 3962)—and during the great warbler waves of the past fall I saw many and captured several.

ICTERIA VIRENS—YELLOW-BREASTED CHAT.—One record—a pair taken by me on June 1, 1896. These birds were common in my old home in Illinois and I know their habits well and am sure they have never been met here on any other occasion.

A List, With Brief Notes, of the Mammals of Dodge Co., Wis.

By W. E. SNYDER, Beaver Dam, Wis.

Dodge County, situated in south central Wisconsin, its principal city Beaver Dam, being 65 miles distance from Milwaukee, is peculiarly adapted, by its geographical location and topographical features, to a large and varied fauna. Within its borders are found level fields, heavy hard-wood timber, tamarack swamps, hills of considerable elevation, willow thickets, large tracts of marshland, some flooded and some now dry, several lakes, some of which are bordered by upland pastures, elsewhere by extensive marshes, several small streams and occasional weedy, worthless tracts of stony hill sides. In these different areas are found congenial homes for numerous species of small mammals—particularly the Rodentia.

The following list embraces 36 species and sub. sp., all of which, except the otter and wildcat, have been actually observed by the writer. That other species occur within our country there can be no doubt. My personal labors have been practically limited to a field extending not further than 3 miles from my home, near Beaver Dam, and at Fox Lake, 10 miles north. Horicon marsh, with its thousands of acres and its surrounding bluffs, has never been explored. In the sandy regions about this marsh I am told that the Pouched Gopher (*Geomys bursarius*) occurs. And in a letter received from Dr. C. Hart Merriam of the Biological Survey, dated February 17, 1897, he writes that the Prairie Meadow Vale (*Microtus austerus*) and three or four species of Long-tailed Shrews (*Sorex hoyi*, *fumeus*, *richardsoni* and *personatus*) should occur here. We are also within the range of the Star-nosed Mole (*Condylura cristata*). But of these seven species only *Microtus austerus*, *Sorex richardsoni* and *Sorex personatus* have come under my observation.

All specimens of which there could be the least doubt of their identity have been named by Dr. Merriam of the Biological Survey and his assistants—and I here wish to extend my thanks to Drs. Merriam and Palmer and Mr. W. H. Osgood for their kindness and labors in my behalf.

In my list no particular order of classification is followed, the Rodentia being given first because they are the most numerous, in species as well as in individuals. The names used are those now

used by the Biological Survey in their many excellent publications.

My observations date from October, 1888.

Spermophilus tridecemlineatus (Striped Spermophile).

This Rodent, known locally as "Gopher," is exceedingly abundant in our county. They frequent pastures, grain fields, roadsides—in fact anywhere except in the timber and flooded marshes. It is not uncommon to find them in dry marshes, even as far as half a mile from any solid earth. Their principal food is grains and grass. One killed on August 11, 1894, had 181 kernels of barley in its cheek pouches.

With us this species goes into hibernation from the first to 20th of October, varying as does the season—and appears again late in March or early in April—as soon as the frost is well out of the ground and the days have become sunny and warm.

Four and five appear to be the usual number of young, and when about one-third grown may be seen playing outside of their underground home. At this period they do not appear at all shy, and should one be surprised far from its home it runs about aimlessly as if lost.

Although they frequently burrow under grain shocks, throwing out considerable quantities of earth, yet seldom are they complained of as a destructive and detrimental animal.

When they first come forth from their winter homes they are shy and quiet. A few weeks of bright warm weather and their whistle may be heard at almost any hour of the day. The last ones seen in the fall are also very shy and quiet, as if ashamed to be seen abroad so late in the season. In the fall they forage from daylight till dark, and I have frequently seen them abroad long after sunset, even as darkness was falling.

The weather effects their habits to a considerable extent. Dark, gloomy days few will be seen, while on bright sunshiny days it sometimes appears as if every living one is about, so numerous are they then.

This species seldom has more than two openings to its underground home and often but one.

My friend, Delos Hatch of Oakfield, had a pure white individual as a pet during the summer of 1901.

On two occasions I have seen one-third grown young late in August, which tends to prove that the species does occasionally bring forth two litters in a year. On one occasion I observed one of these rodents to drag into its burrow a dead Garter Snake

(*Thamnophilus*). This was at a time when food was plenty, therefore I am led to believe that this individual had a liking for this food.

Spermophilus franklini (Gray Gopher—Franklin's Spermophile).

Known generally as "Gray Gopher." From time to time it has been reported to me that these spermophiles are common in certain parts of Trenton and Burnett Townships, but lack of time has prevented me from making any investigations in those localities.

My personal records of this interesting species are three in number, as follows:

The first one, No. 1156 a ♀, was caught when running near the barns, on August 8, 1891.

The second one, No. 1157, also a ♀, was dug from its burrow in an oat field on August 11, 1892.

At both of these dates a thorough search of the farm failed to reveal signs of any more. These two were evidently stragglers.

The third one, No. 1700, a very large and exceedingly fat ♂, was discovered by my father, when en route to Fox Lake, running along the roadside on the Gutgesell farm, 4 miles north of my home. This was on May 22, 1900. On one side of the road was a field of newly sown grain, with a clover field on the other side. The animal ran about aimlessly, as if lost or undecided where to go, and though very adept in dodging its pursuer was finally despatched with a stick. Subsequent inquiry brought forth the claim by the proprietors of the land that they were seen there every year, but I visited the farm several times during 1900 and 1901 but saw no trace of the species.*

This spermophile, unlike the striped species, has several openings to its home, and honeycombs the soil for a considerable space, throwing out a large quantity of earth.

Tamias striatus griseus (Chipmunk.)

An abundant species, frequenting timber and along old rail fences, sometimes considerable distance from timber.

In September, 1899, I found it abundant on the high wooded shores of Fox Lake, frequenting the beaches, and having its home among the projecting roots of trees, on the bank and about old logs. Here it was feeding on the seed of the linden and on mollusca. In the cheek pouches of several which I shot were found numbers of the shell, *Planorbis campanulatus*, a species abundant

*This one weighed 15½ oz. and measured as follows:—Body, 256; Tail, 136; Hind-foot, 56 m. m.

at this place. Strange as it appeared to me, fully 75 per cent. of these were *dead* empty shells, from which the animal had decomposed. This would lead one to believe that it was the hard exterior covering and not the soft animal substance within, which the Chipmucks sought for food.

My earliest record of the spring appearance of this species is March 9, in 1901, when one was seen to enter a hole in a decayed tree stump. At the time the ground was covered with snow and we experienced several hard freezes after that date.

One of their favorite foods is the hazel nut.

Evotomys gapperi (Red-backed Mouse).

Two were seen on November 1, 1901, both under corn shocks on the border of a thicket. One of these, a ♂, No. 1062, was captured.

I have no other record of its occurrence here.

Zapus hudsonius (Jumping Mouse).

Of this long-tailed, kangaroo-like Mouse, I have but four records:

First, a living one seen in a meadow near the thicket where the *Evotomys* was taken, on July 23, 1889. It was not captured.

Second, one my father caught in September, 1898, while I was in Alaska, and which he laid aside for me. I returned October 22, at which time it was in such a stage of mortification that I could not prepare it.

Third, one captured on May 21, 1901, No. 969, within 100 yards of the place the *Evotomys* was taken.

Fourth, one captured October 12, 1901, No. 1045, by my father, on almost exactly the same spot as the last one.

All of these were taken on the border, or within 200 feet, of the same thicket.

Peromyscus bairdi (Michigan Wood Mouse.)

This rodent is surpassed in numbers, in my locality, only by the Common Vole (*Microtus pennsylvanicus*).

It is abundant with us, frequenting fields, meadows, along rail fences, stone walls and in the timberland. If you see an old rail fence, overgrown by weeds and hazel bushes, be assured that *P. bairdi* are found there in numbers. Here they have their cozy home within some hollow rail. On one occasion I found nine adult individuals in one such nest.

These Mice gather in considerable numbers under shocks of grain standing in the fields, but aside from occasionally cutting the bands of bundles they do little or no harm.

Peromyscus leucopus (White-footed or Wood Mouse).

Our White-footed Mouse of the *leucopus* group may, by subsequent study, prove to be the sub-species *noveboracensis*.

This species occurs sparingly with us in the ratio of 50 *bairdi* to one *leucopus*.

Though generally considered more of a woodland species than *bairdi*, yet I have taken them in traps in grassy fields a mile from any timber.

Mus decumanus (Brown or Norway Rat).

Common about barns, in basement cellars, under grain stacks, in fields during the summer, about stone walls—anywhere that food can be found and sufficient cover to their taste.

In September, 1899, one was seen running along the beach at Fox Lake, fully a mile from any building.

Mus musculus (House Mouse).

Abundant, about buildings and in the fields, often taken in small traps set for Voles, Wood Mice and Shrews.

Microtus pennsylvanicus (Common Meadow Vole).

Beyond all question the most abundant mammal of Dodge County, even outnumbering the Common Mouse and Brown Rat.

They may be found in pastures, fields, meadows, marshes, both dry and flooded, along fences—practically everywhere except in woodland. Some years they are exceedingly abundant in a given field, and the next season, under precisely similar circumstances not one can be found there. My only explanation for this is that they may perform slight migrations, from one location to another. One season a certain clover field contained hundreds of them, the next season the clover crop was even heavier than the previous year, but not one could be found.

This species brings forth two and perhaps three litters per year, varying from 5 to 9 young, in number, though on but one occasion have I observed the latter number. A farmer once reported a nest of 12 young, six of which were one-half the size of the other six. In this instance it is fair to presume that two females occupied the same nest as their home.

My collection contains four albinos of this Mouse, 3 females and one male, taken as follows: August 7, September 14, September 29 and September 30, all in 1899. No other albinos have been seen or reported to me. These were taken on the farm, 3 in one field and the fourth one fully half a mile distant.

Microtus austerus (Prairie Meadow Vole).

Of this Vole I have a single record, one taken by a friend on April 26, 1896, No. 1021, who, noting its color, thought it might be something desirable to me. Not being at home at the time it was put in a jar of alcohol. Subsequently it was removed and a skin prepared. It was labelled "Taken on land," by which I infer that the collector wished to state that it was not taken in timberland or on the marshes.

It should occur commonly within our county and probably does in some localities not yet visited by me.

Sciuropterus volans (Flying Squirrel).

This form of the Flying Squirrel is common about Beaver Dam, making its home within the recesses of hollow trees and in old woodpecker excavations.

They sometimes congregate in large numbers in some snug retreat, to pass the winter. An instance of 22 being found in one hollow oak is recorded by the writer in *The Oregon Naturalist* of January, 1897.

Sciurus ludovicianus (Western Fox Squirrel).

In the immediate vicinity of Beaver Dam this is the only Squirrel which can be classed as common. They may be found inhabiting nearly every bit of timberland, and sometimes even in groves of not more than 50 trees.

In winter they make their homes within some hollow tree, in a great nest of dry leaves, where they lie curled up in severe weather, but on warm days may be seen running about, digging in the snow for food. In the spring, when the oak leaves have reached their full development, the Squirrel builds a huge leaf nest in some tree, usually near the top, in which the baby squirrels are born, and to which the parents repair for their night's rest and sleep.

Two black ones were killed in Trenton township some 15 years ago, and I frequently saw one black one during the winter of

1900-1901. These are the only cases of complete melanism of which I have record (that is, as pertains to Dodge County).

I have in my possession three interesting specimens tending toward melanism:

No. 1093, ♂, taken during December, 1891, at Fox Lake, by G. A. Morrison.

No. 1440, ♀, taken October 23, 1899, by Fred. Kimball.

No. 1470, ♀, taken December 19, 1899, by the writer.

These three have the under surface, inside of legs, throat, low jaws and cheeks black, elsewhere their color is somewhat darker than usual in *ludovicianus*.

Sciurus leucotis (Northern Gray Squirrel).

In 1888, when I came to Beaver Dam, I found the Gray Squirrel common and a Fox Squirrel was a prize indeed. About 1896 the Fox Squirrel increased wonderfully in numbers and apparently has driven out the Gray, and now the *latter* is the hunter's prize. Elsewhere in the county, notably about Randolph and in Oak Grove townships, the Gray is still common. Since 1898 I have seen but one *leucotis* on the farm—that one on July 18, 1901.

Last September I mounted a snowy white albino, which had been killed five miles south of town, on Sept. 5th. The eyes were pink and its coat of fur immaculate.

One skull in my possession, No. 1535, from Jefferson Co., shows an abnormal condition of growth of the incisor teeth. The two upper and right lower incisors are of unusual length. The other lower incisor is broken off close to the jaw bone. In this section of the jaw a shot is imbedded—which explains the strange growth. In early life this incisor was broken, and the others, lacking the usual opposition, became abnormally elongated and de-

This squirrel was fat and appeared healthy.veloped in the form of a curve.

Sciurus hypophaeus (Merriam's Squirrel.)

The remarks which have just been made about *Sciurus leucotis* apply equally well to this species, although *hypophaeus* appears to be common in but one locality—that near Randolph. This species has been driven out by the Fox Squirrel.

From January, 1899, to the present date I have seen but one near my home—that one having been seen the past summer.

Merriam's Squirrel is apparently, in its distribution, restricted

to Wisconsin and Minnesota. Black phases appear to be not rare in Minnesota and Dunn Co., Wis.

Sciurus hudsonius loquax (Southern Red Squirrel.)

Frequently, during my residence here, Red Squirrels have been reported to me. In reply to a request to my informants to bring me one I have received several Fox Squirrels, and I had really begun to doubt the occurrence of the Chickaree in Dodge County.

Imagine, therefore, the pleasure to me, to have a youthful hunter of this city bring me one of these squirrels, which he had shot on Oct. 30th last, about 8 miles southwest of this city. The day he obtained this one was a bright, warm day, and he chanced upon a woods (consisting wholly of oak), where, he tells me, he could have taken a dozen on that day, but only shot one, because he did not know whether they were anything I cared for. He subsequently visited the woods, but always on stormy, cloudy days, when there were few to be seen, and brought me three more.

Arctomys monax (Woodchuck.)

Known locally as Woodchuck. I have never heard "Ground Hog" applied to this animal about here.

An abundant rodent, frequenting woodland, meadows, stone fences and pasture lands. Some years more abundant than others. His excavations in the meadows are a menace to horses, owing to their stumbling into them and occasionally breaking a leg, otherwise they do little harm.

One has been observed with abnormal incisor development, as had the squirrel mentioned elsewhere in this paper.

One season, a few years ago, they were so abundant that at least 47 were killed upon our 400 acre farm.

A favorite home site of the Woodchuck is the little groves surrounded by marsh land, upon every one (of which I have knowledge), in this vicinity (some 16 in number), a den may be found. And one colony has become established on an island, of perhaps three-fourths of an acre in extent, in our lake.

During 13 years' residence here I have seen this animal abroad every month of the year except December and January. A warm spell, in early February, will call him forth, though snow yet covers the ground.

The largest one which I have ever weighed tipped the scales at 12 pounds, less 3 ounces. One black one has been reported.

Not infrequently do I find them in trees. One old settler had taken up his abode in a timber lot and in the midst of a patch of

blackberry bushes. These bushes hid his view, so he selected a near-by oak as his sentinel tower, and approaching the den one would be sure to see him up his tree, at a height of about 8 feet, from which he would slide down, when you approached too near, and scamper away to his den.

Fiber zibethicus (Muskrat.)

An abundant resident of our flooded marshes and found sparingly along streams and ditches. In the former place he erects his mud house, in the latter his home is in the banks, with the entrance under water.

Some winters large numbers leave the marshes and wander over the country. Of 120 such wanderers taken, 90 proved to be males.

Mephitis sp. (Skunk.)

Our local Skunk is presumably the Northern Plains Skunk—*Mephitis hudsonica*.

This animal is common in the county, though rather scarce in my immediate neighborhood, due to persistent trapping.

The Skunk is nocturnal, though on two occasions I have seen them abroad during daylight. One late October day I saw a jet black one run through a pasture, about 3 P. M., and enter one of the 6 entrances to an old established Woodchuck colony. As this stage of pelage was worth about \$5.00 at the time, and being a boy trapper in my 'teens, I coveted that particular animal, but my work held me down until some time after sunset. I then hastened to the place and carefully set a trap at each opening, and there the traps remained undisturbed for 4 days. My coveted prize evidently having left the dens the day he was seen and ere I had my traps set.

The other was seen running along the lake shore on a bright June day, and my companion shot it, but not before it had made itself known in its own peculiar manner. This one was normally marked.

A series of this mammal shows considerable variation in the amount and distribution of the white stripes. One albino has come to my notice.

This is one of our most beneficial mammals, though he does occasionally visit the farmers' poultry house. Show me a meadow with little holes dug here and there at the roots of the grass, and I will prove to you that the meadow is infested with white grubs—the larvæ of the June bug (Order Coleoptera-genus *Lachnosteria*)—which are a favorite food of the skunk. Besides grubs he

destroys large numbers of grass-hoppers, injurious beetles, and other detrimental insects.

Taxidea Americana (American Badger.)

This animal, which figures so conspicuously on our state shield, was once common in Dodge County, but at the present day I dare venture the assertion that there are not upward of a dozen living examples left. The settlement of the country, above all other causes, has driven them away, for this is an animal which loves solitude.

During the past 12 years 3 or 4 live ones have been exhibited at our county fair, mostly taken in Burnett Township, but I am told there are none left there now.

A den was located in that township, some 4 years ago, on Col. Lockwood's farm. The Colonel would suffer no one to molest, them, but the Colonel left the farm two years ago and I have heard no more about the Badgers.

Several years ago I gave up all hope of securing one from our county for my collection. Last fall two young men called on me to enquire if I would buy a Badger, if they caught one. I assured them I would, never expecting to hear more about it. But on Jan. 9th, of this year, one of these boys brought me the Badger, caught in a steel trap, which had been set in the mouth of its burrow the night before.

This one, No. 1089, was a ♂, very fat and large, weighing 19 lbs. It was taken 5 miles south of Beaver Dam, the burrow being situated in a strip of woodland.

The teeth show no wear, from which I judge that it is a young animal.

Procyon lotor (Raccoon.)

Occasionally taken in the more heavily timbered parts of the county. Seldom a winter passes but that I hear of the capture of one or two.

One taken near Randolph on Oct. 21, 1900 (No. 1843), weighed 11½ lbs. Sex ♂

The majority of reported captures show this animal to prefer the vicinity of some lake or water course, as his domain.

Vulpes fulvus (Red Fox.)

Not rare, throughout the county, becoming scarcer gradually, is the opinion of fox hunters in general. Not a winter passes but that I learn of one or more seen or captured. Favorite localities

appear to be Trenton and Burnett Townships, and in the country surrounding Horicon marsh.

Vulpes fulvus argentatus (Silver Fox.)

Rare, if it occurs at all, at the present day. When the country was new and but thinly settled it was occasionally taken, the older settlers inform me.

I was one of three lads to start one from an arbor vitæ hedge within the city, where every lot had a house upon it and five blocks from Front street, in 1890. It was shot and its pelt sold for \$35. Since then none have been reported.

Lutra canadensis (Land Otter.)

The Otter was common in our county in the days of its early settlement, but has been practically, perhaps wholly, exterminated. Adam Egotz, once a professional hunter and trapper, and a man whose word may be relied upon, tells me he saw the slide of one of these animals on the shore of Beaver Dam Lake early in the '90's. He endeavored to trap it, but without success, and it soon disappeared.

I also have one other record of one actually captured here some time since 1890, but the record is not accessible at the time of this writing.

Lynx rufus (Wild Cat.)

Not rare when the forests covered the greater part of our country 20 to 40 years ago.

In October, 1898, one was killed near Alderly, this county.

Sorex richardsoni (Richardson's Shrew.)

Of this Shrew I have but one record, ♀ (No. 1183), which a Shrike had impaled on a willow, in a large marsh, found on April 1, 1899.

Persistent trapping in the surrounding marshes has failed to secure another specimen.

Sorex personatus (Masked Shrew.)

Of this *Sorex* I have five records: First, No. 1369, one caught by father under a barley shock, at noon (we were working in different fields that day). He told me he had a shrew the like of which he had never seen before, and characterized it by calling it a "mouse-colored Shrew." This was on July 31, 1899.

Second—No. 1493, trapped by me along a grassy fence line on Jan. 10, 1900.

Third—One found lying between the railway rails at Minnesota Junction on Sept. 1, 1900. It was too far advanced in decomposition to preserve.

Fourth—No. 1883, caught Dec. 13, 1900, as it ran from under a log in a grove of oaks, a grove covering fully an acre.

Fifth—No. 951, found dead on March 15, 1901, near the barns.

It will be observed that these five were found in various locations—in timber, grain fields and along fence lines. From this fact, and also owing to its diminutive size, swift movements and nocturnal, retiring habits, I feel assured that it is a common species, though so seldom observed.

Blarina brevicauda (Short-tailed Shrew.)

This Shrew is common about stone walls, rail fences and under brush piles in the woods, and large boulders about the fields.

It is nocturnal in habits, though occasionally seen abroad in the day.

This species is the bane of the trapper of small rodents. Often do I find in my traps a *Peromyscus* or *Microtus*, which has been ruined for a skin, by this carnivorous creature.

Lepus floridanus mearnsi (Western Cotton-tail.)

The Western Hare is common, and even abundant, in some districts, and scarce in others. They frequent all conditions of habitats, excepting the flooded marshes, but prefer woodland and grassy, weedy tracts.

In severe weather they spend their hours in some excavation in the earth, made by a skunk or woodchuck. I have no proof that they ever excavate their own homes. During the warm months they may be found scattered over the fields and meadows.

Hunters have brought me reports from time to time of a very large big-eared Rabbit, occurring in a tamarack swamp near Lost Lake. It is unlikely that any Jack Rabbits occur in Wisconsin, and as these are said to be brown in winter as well as summer, they cannot be the Varying Hare (*Lepus Americanus*), a species common in northern Minnesota and presumably occurring in northern Wisconsin. Their big-eared fellows are presumably very large examples of the common western form of *floridanus*.

The 27th of last October, a local hunter killed a Rabbit which had a white stripe, extending upward from its nose to the base of the ears. Its greatest width is nearly an inch. The head was left for me at a local store, and, on subsequent inquiry, I was informed that the rabbit was otherwise marked as common with the species.

Lutreola vison (Mink.)

The Mink is a common resident of our marsh lands and timbers bordering on the various lakes of the county, where they find food abundant, for rarely do I learn of their depredations on poultry houses.

In the marshes they find frogs, crayfish, mice and eggs in abundance during the warmer months; in winter they find mice, and doubtless also catch some fish.

The Mink is a cautious animal, one that does not foolishly set his foot on the pan of a steel trap, so the "kid trapper," as the professional trapper calls the youthful school boy, secures but few, perhaps not one, in a season. Consequently their numbers do not seem to diminish. The winter of 1900-1901 they were unusually common, judging from reports from all over the county.

Personally, but one has been seen, far from a marsh. This one was seen running through a stubble field about mid-day, on Aug. 6, 1889.

Hohl's woods, about four miles north of town, with its high banks, projecting tree roots, and shore line of great boulders, is a favorite home of the Mink.

Putorius cicognani (Bonaparte's Weasel.)

In a series of 16 Weasels from Dodge County, submitted to Dr. Merriam, he found 4 of this species and 12 of the New York Weasel. This may, I think, be taken to show the ratio in abundance of the two species, for considering the two together, it can be said that Weasels are abundant with us. This series represented individuals from various habitats and all stages of pelage.

This species has been taken in burrows in timber land, in marshes, along the lake shore and about stone walls.

Putorius noveboracensis (New York Weasel.)

The relative abundance of this Weasel I have stated under the remarks on the preceding species.

Lasiurus borealis (Red Bat.)

The Red Bat is an abundant species with us, being partial to timber, about ponds, lakes and streams, from whence I judge that it feeds largely on mosquitoes and other *Diptera* of similar habits.

Lasiurus cinerea (Hoary Bat.)

The past season I first met this large, interesting Bat. Early in September, I observed a large bat flying among the burr oaks scattered about in an upland pasture. They seemed to come, at dusk, from the trees, but a thorough search made one day of some

30 trees, I failed to find a bat. That they were there I feel sure, which goes to show how well their color and position harmonize with their surroundings, when hanging head downward, with their wings wrapped about them, as they take their daylight sleep. When they first appeared each evening they would fly close about the trees, within the dark shadows, then rise high in the air and work off toward the northwest. This northwestward movement was observed each evening when I visited their haunts.

One was found dead on the ground, evidently in nowise injured, by which I learned their identity.

I *certainly* had never seen them here before, which can be explained when we remember the well-known migratory habits of the bat tribe.

Lasionycteris noctivagans (Silvery Black Bat.)

An abundant species, particularly so about the streets of the city, in the early evening, where they may be seen in numbers, darting about among the trees.

I have knowledge of several houses, where these bats roost in large numbers between the closed blinds and the windows. One of these roosts was investigated one year, during the height of the bat season, and there was an almost solid column of bats the whole length of the blind—clinging to blind and window casings—a conservative estimate being 300 bats.

Myotis lucifugus (Little Brown Bat.)

This species came with the migration of Hoary Bats in September, 1901, previous to which I had never taken them.

One morning some 60 were found in a granary, having gained access through a broken window pane. They used this roost for only three nights, after which they were seen no more.

Castor fiber (Beaver.)

Exterminated Species.

The Beavers, many years ago, had constructed a dam on the creek which flows out of the present lake at this place. Prior to that time our lake was merely a stream flowing through extensive marshes. This dam gave to our city its present name, but the Beaver has long since disappeared from the county.

Odocoileus virginianus (Common Deer.)

Many years ago these ruminants occurred here, so old settlers inform me.

The Porcupine (*Erethizon dorsatum*) and the Black Bear (*Ursus americanus*) doubtless were found here years ago, and the Canada Lynx (*Lynx canadensis*) doubtless has occurred.

BULLETIN

OF THE

WISCONSIN

NATURAL HISTORY

SOCIETY

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MILWAUKEE, WISCONSIN.

The Wisconsin Natural History Society,

MILWAUKEE, WISCONSIN.

ORGANIZED MAY 6, 1857.

OFFICERS AND DIRECTORS.

EDGAR E. TELLER, PRESIDENT 170 29th Street, Milwaukee
DR. CHAS. D. STANHOPE, VICE PRES'T . 204 Grand Ave., Milwaukee
CHARLES E. MONROE, GEN. SEC'Y . 310 Goldsmith Bldg., Milwaukee
LEE R. WHITNEY, TREASURER . . . 225 Post Office Bldg., Milwaukee
CHARLES E. BROWN Public Museum, Milwaukee

ADOLPH BIRSACH, Secretary of Combined Biological Sections.

DIRECTORS OF SECTIONS.

Archeology . . . Henry A. Crosby	Mineralogy Louis Lotz
Botany Ernest Bruncken	Numismatics . William F. Sandrock
Entomology . . . Charles E. Brown	Ornithology . . . Edward E. Voss
Geology Charles E. Monroe	

REGULAR MEETINGS.

These are all held in the Society's lecture room in the Museum-Library Building, Milwaukee.

Meetings of the combined biological sections take place on the 2nd Thursday of each Month at 8 P. M.

The Archeology and Numismatics sections meet on the 3rd Thursday of each Month.

General Meetings are on the last Thursday of each Month except July and August.

Meetings of the Archeologists and collectors of the State are to be held semi-annually under the direction of the Archeology section, for the purpose of furthering the cause of Wisconsin Archeology.

PUBLICATIONS.

The "Bulletin of the Wisconsin Natural History Society."
The "Wisconsin Archeologist."

MEMBERSHIP DUES.

City Members, \$3.00 per annum; Non-resident Members, \$1.00 per annum;
Life Members, one payment of fifty dollars.

BULLETIN

OF THE

WISCONSIN NATURAL HISTORY SOCIETY.

VOL. 2, New Series.

JULY, 1902.

No. 3.

Exchanges should be mailed to the Wisconsin Natural History Society, in care of the Public Museum, Milwaukee, Wis. Communications should be addressed to the General Secretary.

Summary of the Proceedings of the Society.

March, April, May and June, 1902.

THURSDAY, March 27, 1902.

The meeting was called to order by the president, Mr. Edgar E. Teller.

There was a large attendance both of visitors and members.

The president read a communication from Mr. William J. Bennetts, the recording secretary, tendering his resignation on account of the fact that he was about to leave the city. The resignation was regretfully accepted.

Mr. Charles E. Monroe was elected recording secretary to fill the vacancy thus caused.

Mr. Charles E. Brown, general secretary of sections, presented a report of the section meetings held during the month.

The following names were reported: Mr. Emil Schenck, of Deerfield, for active membership; Mr. E. H. Stiles, of Richland City, for honorary membership. Referred to the board of directors for their action.

Mr. Carl H. Doerflinger, in behalf of the committee on revision of charter and by-laws, presented a revised draft of the articles of association of the society. Action thereon was deferred until the next regular meeting.

Mr. Charles E. Brown gave notice of the recent deaths of Frederick Rauterberg and Herbert J. Johnson, members of the society. The secretary was instructed to express to the families of the deceased the sense of loss felt by the society in the death of members so actively interested in scientific pursuits, and the sympathy of its members in their bereavement.

Prof. Stuart Weller, of the University of Chicago, was then introduced by the president and delivered an interesting address on "The Northern Rocky Mountains." The lecturer gave an account of the work done during the previous summer by an expedition sent out by the United States government to determine and mark the boundary line between the state of Montana and the British province of Alberta. The lecture was illustrated with lantern slides showing the scenery, geology and topography of the region traversed. One of the most striking features represented was an extraordinary fault, with over-thrust, resulting in the super-position of primary rocks above later cretaceous formations.

A vote of thanks was extended to the lecturer.

The meeting then adjourned.

THURSDAY, April 24, 1902.

Annual meeting of the society; thirty-three members present.

In the absence of the president and at the request of the vice-president the meeting was called to order by the recording secretary.

On motion of Mr. Ernest Bruncken, Dr. George W. Peckham was requested to take the chair and did so.

The minutes of the previous meeting were read and approved.

Mr. Charles E. Brown presented a report of section meetings held during the month.

Mr. George A. West, treasurer, presented his report for the year, containing the following statement:

Cash on hand May 1, 1901.....	\$232.73	
Cash received during year from dues of members.	287.95	\$520.68
Total disbursements during year.....	\$417.57	
Balance on hand April 24, 1902.....	103.11	\$520.68

Messrs. David Harlowe, Charles D. Stanhope and Charles E. Brown were appointed a committee to audit the treasurer's report.

Mr. Charles E. Brown, as secretary of sections, presented a report for the year showing a large gain in membership and increased interest in the work of the sections. The archeological section embraced 102 members, from all parts of the state. Efforts would be made to increase the membership of the botanical and ornithological sections during the coming year. The report recommended that each section be given full power to formulate its own by-laws and elect its own director.

The amendments to the articles of association proposed by the committee on revision were read by the secretary. Final action on the proposed amendments was deferred until the next monthly meeting in order that proxies might be obtained from absent members after full information had been given them of the character of the proposed amendments.

Applications for membership were received from the following persons: Charles H. Yunker, Dr. F. F. John, Arthur Nuesse and Dr. Otto C. Thienhaus, all of Milwaukee; F. M. Le Count, of Hartford; N. E. Carter, Elkhorn; M. E. Morrissy, St. Francis; N. Hollister, Delavan. Referred to the Board of Directors.

The secretary offered a resolution 'that the transfer heretofore made to the Public Museum of the city of Milwaukee of the collection of books and pamphlets in the possession of the society, as well as of others which may hereafter come into its possession, be and is ratified and approved by the society.' Action upon the foregoing resolution was deferred for one month in order that proxies might be secured from absent members upon the resolution.

On motion of Mr. Henry R. Dennison an informal ballot was taken for president for the ensuing year. Thirty ballots were cast, of which Mr. Edgar E. Teller received twenty-five. The secretary was instructed to cast the unanimous ballot of the society for Mr. Teller, which was done and Mr. Teller was declared unanimously elected.

Other officers were then elected as follows:

Vice-President—Dr. Charles D. Stanhope.

Recording Secretary—Mr. Charles E. Monroe.

Corresponding Secretary—Mr. Charles E. Brown.

Treasurer—Mr. Lee R. Whitney.

Librarian—Mr. Adolph Biersach.

The meeting then adjourned.

THURSDAY, May 29, 1902.

The meeting was called to order by the president, Mr. E. E. Teller; twenty-two members present.

The minutes of the annual meeting were read and approved.

The secretary moved the adoption of the following by-law: "Any member may vote by proxy on any matter at any meeting." The motion was carried unanimously and the by-law adopted.

The question of the adoption of the amended articles of association, recommended by the committee on charter revision at the last meeting and laid over for one month, came up for final action,

due notice of the proposed amendments having been mailed to all the members of the society by the recording secretary pursuant to the order of the board of directors.

The amended articles of association were then read and approved section by section and then adopted as a whole by the unanimous vote of the twenty-two members present and of eighty-four proxies held and voted by the following persons: By the secretary, 61; by Mr. Charles E. Brown, 12; by Dr. Charles D. Stanhope, 7; by Mr. Lee R. Whitney, 2; by Mr. Charles H. Doerflinger, 1; by Mr. Adolph Biersach, 1; making a total of 106 votes.

(A copy of the amended articles of association is printed elsewhere in this Bulletin.)

The resolution "that the transfer heretofore made to the Public Museum of the City of Milwaukee of the collection of books and pamphlets in the possession of the society, as well as of others which may hereafter come into its possession, be and is ratified and approved by the society," offered by the secretary at the last meeting and laid over for one month, then came up for action by the society, due notice of the resolution having been mailed to every member of the society by the recording secretary pursuant to the order of the board of directors.

The resolution was adopted by the following vote:

Members present voting for the resolution.....	20
Proxies held and voted by the secretary.....	61
Proxies held and voted by Mr. Brown.....	12
Proxies held and voted by Mr. Whitney.....	2
Proxy held and voted by Mr. Doerflinger.....	1
Proxy held and voted by Mr. Biersach.....	1
Total.	97

Opposed to the resolution were the following:

Members present voting against the resolution.....	2
Proxies held and voted by Dr. Stanhope.....	7
Proxy held and voted by Mr. Denison.....	1
Total.	10

The secretary reported that the following persons had been elected to membership at a meeting of the board of directors held May 8:

Honorary member, E. H. Stiles, of Richland City.

Active members: Charles H. Yunker, Dr. F. F. John, Arthur Nuesse and Dr. Oscar C. Thienhaus, all of Milwaukee; Emil

Schenck, Deerfield ; F. M. Le Count, Hartford ; N. E. Carter, Elkhorn ; M. E. Morrissy, St. Francis ; N. Hollister, Delavan.

The offices of corresponding and recording secretaries having been abolished by the amended articles of association just adopted, and the offices of general secretary and an additional director having been created, an election was then held to fill the new offices.

Mr. Charles E. Brown was unanimously elected a director.

Mr. Charles E. Monroe was unanimously elected general secretary.

The committee on revision of charter and by-laws made a further report, recommending the adoption of a new set of by-laws, prepared by the committee, as a substitute for the existing by-laws.

The proposed new by-laws were then read section by section, and after some amendments had been made, were unanimously adopted.

(A copy of the new by-laws is printed elsewhere in this Bulletin.)

Mr. Denison moved that a committee of three be appointed to report upon members who had died during the preceding year with suitable resolutions. The motion was unanimously adopted and the president appointed Messrs. Denison, Doerflinger and Brown such committee.

The application for membership of Rev. E. C. Mitchell, of St. Paul, Minn., was presented and referred to the board of directors.

The meeting then adjourned.

THURSDAY, June 26, 1902.

Meeting called to order by the president; thirty persons present.

The minutes of the last meeting were read and approved.

Messrs. H. R. Denison, C. H. Doerflinger and C. E. Brown, the committee appointed at the last meeting, presented the following memorials and resolution:

CHARLES VON BAUMBACH.

Born at Kirchheim, in the Grand Duchy of Hessen, on June 18, 1840, a scion of an ancient family, he came to this country in 1848 with his father, who had been implicated in the revolutionary movement of the time, and settled in Ohio. After receiving a good education he came to Milwaukee with the family in 1857, the year when our society was organized. He contributed to its

early collections specimens bagged on his hunting expeditions in Wisconsin and in the south, where he served in defense of the Union from the beginning of the civil war until November, 1863. He joined Company C of the Fifth Wisconsin Infantry, as a private, was promoted to the positions of corporal, sergeant and second lieutenant; then joined the Twenty-fourth Wisconsin Infantry as captain of Company C, and became major of that regiment. He took part in the Peninsula campaign, the siege of Yorktown, and the battle of Williamsburg, where he was wounded; also in all the battles in which the Twenty-fourth Wisconsin was engaged until the time of his resignation on November 28, 1863.

Actively interested in all cultural endeavors, after his return from the field, he became a member of our society in 1866 and remained true to it until the day of his demise, which occurred at his home in Milwaukee on December 23, 1901, after a successful business career as a pharmacist, and founder and head of the wholesale drug firms of Baumbach & Rosenthal, Charles Baumbach Company, and Baumbach, Reichel & Company.

Charles von Baumbach will be remembered by his comrades in arms, by the older members of our society, and a host of other friends, as a genial companion and public-spirited citizen.

ADAM CONRATH.

This name first appears on the membership list of our society in 1881. At the time of his premature death, at the age of 52 years, on December 19, 1901, he had therefore been a member for twenty years.

Graduated with high honors from the Philadelphia College of Pharmacy on March 11, 1873, he became one of the most studious and enthusiastic of his profession, interested not only in *materia medica*, but especially in botany, his favorite branch of science, and in archeology.

On April 3, 1881, he was elected one of the directors of botany and was re-elected many times in subsequent years. The society's museum, now the Public Museum of the City of Milwaukee, received many gifts from him, particularly for the herbarium. He gave much attention to the observation of alien plants introduced and naturalized in Wisconsin and contributed to the known flora of the state a number of species he first discovered. He contributed many papers and shorter communications at the meetings of our society.

For many years he was associated with Hon. Chris. Widule in the drug firm of Widule & Conrath. As a member of the State

Board of Pharmacy he conducted or participated in the preparation of its examinations.

He collected one of the most complete herbaria of Wisconsin plants and his enthusiasm moved many students to put forth their best efforts.

He was an active and valuable member of our society, a pleasing colleague and helpful collaborator.

AUGUST HECKER.

He was born at Selters, province of Nassau, on June 17, 1834, received a good education and with it imbibed a warm appreciation of the beauties and wonders of nature. He was a very young man when he emigrated in 1850, was soon engaged in the wholesale grocer firm of Inbusch Bros. and served the same house for 50 years as a traveling agent and business representative. He was interested in natural history, literature and music. While he did not make any systematic collections himself he brought many specimens for the museum from his business trips and hunting expeditions. He belonged to the Wisconsin Natural History Society as early as 1868, remaining a member until his death, which occurred on April 23, 1901.

Warm-tempered, like the volcanic region of his birth, he was quick to do good and ever ready to support a good cause. His heart has come to rest under the monument set for him by love in Forest Home Cemetery, where Flora's children offer their fragrant blossoms and his little winged and feathered friends sing sweet tunes to the accompaniment of Aeol's harp.

Resolved, That the foregoing memorials to our deceased members, Charles von Baumbach, Adam Conrath and August Hecker, be spread upon the records of the society and that the general secretary be instructed to send a copy of them to the families of the deceased with appropriate expressions of condolence on behalf of the society.

The foregoing resolution was unanimously adopted.

Mr. Brown presented reports of section meetings as follows:

1. A meeting of the combined biological sections, held June 12. At this meeting Mr. Adolph Biersach was unanimously elected secretary for the ensuing year. The election of directors of sections was deferred until the fall. Dr. S. Graenicher read a paper on "Insects Bred from Elder Stems." Mr. Brown described some fungi new to the Milwaukee County list, exhibiting specimens.

2. A meeting of the archeological section, held June 19. At this meeting the secretary presented his annual report. Plans were discussed for the work of the coming season. Mr. Henry A. Crosby was elected director. Messrs. W. H. Elkey of Milwaukee and P. O. Griste of East Troy, presented some notable exhibits.

The general secretary reported that Rev. E. C. Mitchell, of St. Paul, Minn., had been duly elected a member of the society by the board of directors at a meeting held May 29, 1902.

Dr. George P. Barth then exhibited and described the advantages of a new type of artificial ants' nest. This consists of two glass jars or bottles, one within the other, the space between the two being filled with sand. This contrivance permits the ants to excavate both vertical and horizontal burrows, capable of easy examination and easy to handle, and seemed to the speaker to possess advantages over the flat nests.

Hon. Publius V. Lawson, of Menasha, read a paper on "The Buried Forests of the Fox River Valley." (A summary of this paper is printed elsewhere in this Bulletin.)

Applications for membership were received from Miss Olive C. Wheeler and Pierson L. Halsey, of Milwaukee; and from Bernhard Gerhard, of St. Louis, and P. H. Hamilton, of Two Rivers.

The meeting then adjourned.

Amended Articles of Association.

ARTICLE I.—This corporation being the successor of "Der Naturhistorische Verein von Wisconsin," is organized for the purpose of arousing and sustaining an interest in the study of Nature and especially of facts and materials pertaining to the natural history and ethnology of the State of Wisconsin.

ARTICLE II.—The name of this corporation shall be "The Wisconsin Natural History Society," and it shall be located in the City of Milwaukee in said State of Wisconsin.

ARTICLE III.—This corporation is formed without capital stock and no dividend or pecuniary profits shall be declared to the members thereof.

ARTICLE IV.—The general officers shall be President, Vice-President, General Secretary and Treasurer, and they, together with one additional member to be elected by the Society, shall constitute the Board of Directors.

All the officers herein specified shall be elected at the annual meeting. Vacancies in any office may be filled by election at any regular meeting.

ARTICLE V.—The principal duties of the several general officers shall be those usually pertaining to such offices and such other duties as may be prescribed by the by-laws of the corporation.

ARTICLE VI.—Members shall be elected by vote of the Board of Directors and shall pay such sum upon admission and such stated dues thereafter as may be required by the By-Laws.

Members may be discharged on their own request by striking their names from the list of members kept by the Secretary and Treasurer. Any member who is in arrears for dues for three years may be dropped from membership by the Board of Directors.

The Board may also elect honorary and corresponding members under such regulations as may be prescribed by the By-Laws, but such members shall have no voice in the management of the corporation.

Fifteen members shall constitute a quorum for the transaction of business, except where otherwise required by these articles.

ARTICLE VII.—All the collections and property of this corporation may, by the votes of a majority of all the members of the Society, be donated to the City of Milwaukee. Should the number of members at any time become reduced below eight, it shall be deemed dissolved, and its property shall thereupon become the property of the Public Museum of the City of Milwaukee.

The annual meeting of the Society shall be held on the last Thursday of April in each year. Regular meetings may be held at times prescribed by the By-Laws.

Proposed amendments of these articles may be presented at any regular meeting, but final action thereon shall not be taken before the next following regular meeting and notice of such proposed amendments shall be given to the members before the meeting at which they are to be acted upon, in such manner as the Society or its Board of Directors shall prescribe.

By-Laws.

1. The annual dues shall be \$3.00 for resident and \$1.00 for non-resident members, but members elected in any year shall be required to pay only for such portion of that year as shall remain between the date of their election and the first day of the following May.

Life membership may be obtained by a single contribution of \$50.00.

2. Persons not residing in the city or county of Milwaukee may become corresponding members, if they endeavor to promote the aims and purposes of the Society.

3. Any person may be proposed for membership by any member, at any regular meeting.

4. Persons who have rendered prominent services to the Society or to its aims and purposes, may be elected honorary members.

5. The order of business at the annual meeting shall be as follows:

(a) Reading of the minutes of the last regular meeting.

(b) Unfinished business.

(c) Reports of officers.

(d) Election of officers.

(e) New business.

6. The regular meetings of the Society shall be held on the last Thursday of every month, except July and August. The order of business at such meetings shall be as follows:

(a) Reading of the minutes of the last meeting.

(b) Unfinished business.

(c) Reports of committees and officers.

(d) Correspondence.

(e) Reading of scientific papers and communications and discussion thereof.

(f) New business.

7. The Board of Directors shall transact all business usually performed by such bodies in accordance with the Articles of Association and these By-Laws.

8. The President shall be the presiding officer at all meetings, shall appoint all committees unless otherwise ordered by the members present, shall call extraordinary meetings upon the written request of three ordinary members, shall decide in case of equality of votes, and shall examine and sign all orders to the Treasurer.

9. The Vice-President shall take the place of the President in case of the latter's absence.

10. The General Secretary shall keep an accurate record of all transactions, shall preserve all reports and papers of the Society, keep an accurate list of all members, countersign all orders to the Treasurer, and conduct the correspondence of the Society.

11. The Treasurer shall keep in trust the funds of the Society, pay orders only when signed by the President and General Secretary, and shall present a financial statement at the annual meeting and at any other time when requested by the Board of Directors or the Society.

12. Each officer shall prepare a detailed account of his work during the year and report the same to the annual meeting.

13. The Board of Directors shall have authority to publish from time to time such portions of the proceedings of the Society and such scientific contributions, especially such as are the result of original investigation and research, as shall in their discretion be deemed advisable.

14. Any member may vote by proxy on any matter at any meeting.

15. Any three or more members may, subject to the approval of the Board of Directors, organize a section for work in some particular line within the general purpose of the Society. Such sections may adopt their own by-laws not inconsistent with these By-Laws or the Articles of Association. Sections shall report each month to the Society on their work. They shall not publish anything without being authorized to do so by the Board of Directors.

16. These By-Laws may be amended at any regular meeting by the votes of at least two-thirds of all the members present.

Studies in Plant Distribution.

By ERNEST BRUNCKEN.

3. Upland Brushwoods of the Milwaukee Region.

There are in the vicinity of Milwaukee numerous areas of greater or less extent which are covered with shrubs, either completely, so as to shade the ground and form what are substantially forest conditions; or in more or less sparsely scattered groups and individuals, with grass or herb-covered spaces between. The former type may be called thickets; the other heaths. As to thickets, the present inquiry will be confined principally to those occurring on dry uplands. The extensive thickets found in swamps and river bottoms have essentially different ecological relations, of great complexity, and will be considered only incidentally. As to heaths, the name implies their xerophytic nature. Similar areas of groups of shrubs in marshy land are frequent at some little distance from Milwaukee, but in the territory under discussion are of every limited extent.

There is no evidence at hand whether before settlement of the region upland brushwoods of either class occurred therein. Regarding similar bottom brushwoods the fact is of value that many of the very old trees still standing in the river bottoms have low branches, as if they had stood free at least from the height usually reached by the hydrophytic shrubs. Sometimes these low branches are developed on one side only, as if in its youth the tree had stood on the edge of a shrub-covered glade. (1)

If the absence of evidence to the contrary makes it probable that such glades were not found on the uplands, the shrubs which now compose the brushwoods must either have come to the region since the settlement, or have existed theretofore in the form of underbrush. The latter alternative is indicated by the great frequency of individuals, the considerable variety of species, and above all the fact that the same species to this day occur very commonly as underbrush, especially in the hemi-xerophytic forests. It is not every shrub, however, which occurs in the forest, that takes part in forming brushwoods. On the whole, it may be said that the thicket-forming shrubs are three in number: the witch hazel; the staghorn sumach, and the various species of hawthorn. A large number of other shrubs are liable to be found

1. Of course this evidence is not complete. The glades may have been sedge marshes; only, if that was the case, one ought to occasionally find branches still lower than the height of 8 to 12 feet at which they mostly occur.

mingling with these, such as the hazelnut, choke cherry, prickly ash, and in rather moist places the black alderberry. All these, with the exception of the last-named species, have numerous xerophytic characteristics, as might be expected from their stations.

Before these brushwoods in their typical development are treated in detail, attention should be called to a formation intermediate between a young forest and brushwood. This hybrid formation is found where forest has been cut in a manner to favor the growth of stool shoots. Of the forest trees of the region, especially oak, basswood and ash are apt to form vigorous coppices, and it generally happens that simultaneously with the stool shoots the various shrubs mentioned spring up. For a while they contest vigorously for the occupation of space, but after some years the trees get the upper hand, and the shrubs fall back to the position of underbrush. The areas of this character are usually much less xerophytic than brush areas which have grown into thickets through the heath stage to be described below. Consequently, mesophytic shrubs, like various species of *Ribes*, which are never found in the heath, are common in them. The mesophytic conditions of these areas are easily explained by the fact that owing to the comparatively quick growth of the stool shoots the soil is not left uncovered as long as it is where no stool shoots are found. Consequently the humus accumulated while the forest was still standing is not so completely oxydized as where there are no stool shoots.

Where the removal of the original forest did not take place in such a manner as to give an opportunity for coppice growth, the first stage of plant life is a vigorous contest between grasses, especially several species of *Poa*; numerous stout herbs, such as asters, golden rod and sunflowers; and the shrubs. As may be expected the areas on which this contest is allowed to proceed undisturbed are almost entirely restricted to steep hillsides, especially those with a southern or western exposure. All better localities are needed for tilled fields, and natural processes of reclothing have no chance to operate. But the places indicated are of no use to the farmer except as pasture land, and are therefore left to themselves, except as to the more or less heavy cropping by his cattle. In addition to the strong insolation caused by their steepness and exposure, these hillsides are apt to be gravelly or full of boulders, so that the conditions are decidedly xerophytic. In the three-cornered fight between the grasses, herbs and shrubs the golden rods and their allies are the first to succumb. 'They last only so long as the forest litter has not yet entirely disappeared. When that has been accomplished the grass covers by far

the greater portion of the surface. With its dense tangle of filiform roots, the dense sward of *Poa* makes it exceedingly difficult for other species to compete. About the only successful rivals are a number of minute mosses, and *Antennaria plantaginifolia*. The latter is almost always present, forming little groups and patches in the sward. Where there are other species in the grass carpet, it will invariably be found that they grow in places where from one cause or the other the sward has been broken or prevented from forming. Thus they will grow from under the edge of a boulder or cobble stone; out of a hole made by an animal; or a place where the surface water has laid the ground bare. Among the species conspicuous in such spots are *Fragaria virginiana*; *Viola sororia*; *Potentilla Canadensis*; here and there *Hedeoma pulegioides*; further *Monarda fistulosa*; *Verbascum thapsus*. It will be noticed that many of these xerophytic heath plants have creeping root stocks, runners and stolons, which fit them to compete with the dense grass better than propagation by seeds could do. Of late years the common ragweed invades these dry hillside pastures in great numbers. It colonizes especially places where sod has been removed, and thence spreads to every bare spot it can reach. Occasionally places are found where one of these herbs, most often *Potentilla*, has managed to drive out the grass from considerable areas, and now forms an exclusive carpet many square feet in extent.

In the meantime, the shrubs which started out evenly with the grasses have established themselves in groups here and there. It is especially *Crataegus* which has its favorite habitat on these dry heaths. There are in this vicinity probably some six or seven distinct species of this genus. But as they have never been thoroughly studied taxonomically, they may simply be grouped as *C. coccinea*, *C. mollis* and *C. punctata*, with their respective allies. They occur within the forest as well as on the heath. But as they need a great deal of light they are apt to assume quite eccentric forms in shady places. Their normal adult form is that of a low tree with spreading crowns, approaching the umbrella-like shape so common in *Mimosa* and other trees of tropical and sub-tropical savannas. In deeply-shaded woods, on the contrary, they shoot up high, with few and thin branches. I have seen hawthorn trees twenty feet high, two inches in diameter, bearing no branches below a height of ten feet above the ground, and then sending out but few and short ones, without the multitude of spurs that make the typical crown of a hawthorn so dense.

An old hawthorn on the heath, however, usually has a sturdy trunk, five or six inches in diameter. Its crown is disposed like a number of galleries one above the other, with distinct intervals;

the tips of the branches sweep within a few feet of the ground. Under its immediate shade the ground is bare of vegetation; but at the edge of the bare spot there is often a ring of mesophytic or moderately xerophytic herbs, such as golden rod, violets, milk-weed, etc. The younger individuals of hawthorn are apt to suffer much from cattle and in their efforts to protect themselves often assume the grotesque shapes described elsewhere. (1) As a result, they remain shrubby much oftener than would be the case if the normal tendency of the genus to assume the tree-like form had its full sway.

It is very noticeable that the shrubs and small trees scattered over the heath tend to grow in groups. It is rare to find a single shrub or young tree. The reason for this may be that single seedlings are almost certain to be eaten or trampled by cattle, while where they occur in patches or groups, some of them at least have a chance of surviving. When they are a few years old, the young shrubs begin to protect each other. The older a group becomes, the more mesophytic the conditions in their midst and for a few feet beyond become, especially on their north and east sides. Soon many mesophytic herbs, such as *Podophyllum peltatum*, *Anemone nemorosa*, asters, golden rod and sun flowers reappear, while *Poa* gradually dies out. More mesophytic shrubs soon make their reappearance. By and by the group develops into a small thicket, and as this spreads and joins with its neighbors, the whole heath may in time be converted into a thicket. While this goes on, young trees, especially oaks and hickories, will have found favorable lodging places among the shrubs, and the development will, if undisturbed, progress until the mesophytic forest has again taken possession of the area.

On heaths of this description, the various species of *Crataegus* are decidedly dominant among the shrubs. The other species most frequently found are the hazelnut and two species of sumach, *Rhus typhina* and *Rh. glabra*. (2) There are, of course, a good many others, such as *Symphoricarpus*, *Diervilla*, *Rosa*, *Amelanchier*, but they rarely give character to an area of considerable extent. On heaths in the close vicinity of the Lake Shore, *Juniperus alpinus* is a very characteristic shrub.

The thickets found in the neighborhood of Milwaukee are not always, nor perhaps even commonly, developed from the *Poa* heath formation. Where the exposure of the slope from which the forest is removed is towards the north or east, so that the insolation is comparatively small, the forest litter does not disap-

1. Bulletin Wis. Nat'l Hist. Soc., Vol. I, page 183.

2. It is a remarkable fact that these two species hardly ever intermingle. *Rh. glabra* seems to be a little less xerophilous than its cousin.

pear so rapidly as in southerly and westerly exposures. Consequently the mesophytic herbs, the asters, sunflowers, golden rods, hold their ground much longer; the grasses do not make so much headway, and often other species of the family, which do not make so dense a sward as *Poa*, are more strongly represented than that genus. The hawthorns, hazelnuts and sumachs have strong competitors in the witch hazel, choke-cherry, prickly ash and others. Where there is a small spring on the hillside, as is very often the case, so that the soil for a few square rods is kept in swampy condition, *Sambucus nigra* is sure to be on hand, while willows and dogwood are very apt to stray up from the valley. The trees from the neighboring forest are sure to join in the race. Generally speaking, the conditions on such northerly slopes are so much more favorable to plant life than those on southerly exposures, that the mesophytic nature of the locality is really never lost. After the trees are cut down, there come a few years during which the ground is mostly bare except for the forest litter and such herbs and grasses as may have occupied the forest floor and continue to flourish in the clearing. Some of the latter will not survive more than a season or two under the changed conditions, but others which delight in the rich, loose soil, but could not tolerate the shade of the trees, will come in. Various species of *Rubus* are sure to grow luxuriantly, and their tangled vines are about the only impediment to the growth of the shrub and tree seedlings. Compared to the many years it takes the forest to reconquer a *Poa* heath, the progress of an area of this sort towards the forest stage is very rapid. The years before a thicket is formed are so few that one can hardly speak of a heath stage. In thickets of this kind the witch hazel is usually so much more abundant than the other shrubs mentioned, that one may properly call this the witch hazel, in distinction from the hawthorn association.

Either of the two species of *Rhus* mentioned above is likely to be met with in both of the two associations just described. But in a few places near the lake shore there are thickets in which *Rhus typhina* is dominant to such an extent that one must properly distinguish them as the Sumach Association. The staghorn sumach seems to have a peculiar liking for the steep, barren clay banks or bluffs along Lake Michigan. It invades them from above, establishing itself first on the upper edge of the bluff and sending root suckers down the almost vertical bank. The beginnings of this operation can be seen in many places all along the Lake. But in several places near Fox Point this enterprising shrub has in this manner conquered the whole bank from top to bottom for many rods.

Another remarkable occurrence of the sumach association is

found near the southeastern corner of the county, within a few rods of the shore. Here it covers an area of several acres on a knoll composed of large crystalline boulders with but scanty soil between. The dominant shrubs are old and tall, and while they stand close together, their thin crowns shade the ground but lightly, so that the floor shows the typical heath vegetation of *Poa*, *Antennaria*, etc. The most interesting fact is that among the sumach grow numerous young witch hazels. These are as yet over-topped by the sumach almost everywhere, but are growing vigorously. It will be interesting to see whether the witch hazel, by reason of greater shade tolerance, will not gradually drive out the sumach and with it the xerophilous floor vegetation, so as in the end to convert this typically xerophytic thicket into a mesophytic one.

Small thickets are occasionally met with, sometimes covering several square rods, which are composed exclusively of a single species. One of the small trees or shrubs which has a tendency to form pure growths is the crab apple. Such crab apple thickets within which not a single foreign shrub is seen, though many other species may occur in the neighborhood, are found in various places along the bluffs of the Menomonee Valley. Another kind of pure growth is sometimes formed by the aspens (both *Populus tremuloides* and *grandidentata*). These species (although not uncommon and growing more frequent if the large proportion of young plants is evidence thereof) do not form a conspicuous feature of the plant life of the Milwaukee region. Where they do occur they usually assume their normal tree form, while farther inland, notably along the Kettle Range in Waukesha County, brush woods composed of aspen shrubs are numerous. Here and there, however, in our territory thickets of aspen are found. In these cases they consist of shoots springing from root suckers that proceed in more or less circular form from the mother plant in the middle. The latter can usually be distinguished easily by its somewhat greater height and trunk diameter, although it never grows to be a tall tree.

Very puzzling is the existence of thickets in one or two places, composed prevalently of *Ptelea trifoliata*. This shrub is found exclusively in the Menomonee Valley and the adjacent bluffs. Here it is exceedingly common, occupying stations of great variety, from those decidedly dry to those which are almost swampy. Nowhere else in this region has it ever been found, to my knowledge, but within its province it propagates freely. It bears seed abundantly year after year, and its seedlings are found of every age. Usually it mingles freely with other species, but occasionally it forms almost pure growths of small extent.

A form of brushwood that has many points of interest are the fence-rows. These straggling and interrupted growths are distinguished for the great variety of species occurring in them. All the upland shrubs of the region, from the xerophilous hawthorns and sumachs to the decidedly mesophytic species of *Ribes* are mingling in this formation, without any apparent distinction, of various associations. With the uplands species are commonly found *Vitis*, *Ampelopsis* and similar creepers, that are more often found in the bottom lands, and occasionally a dogwood flourishes in such places far away from its swamp. As to what may be the cause of the comprehensiveness of this fence-row vegetation, I have no theory to offer.

4. List of Plants collected on the Door County Peninsula, Wisconsin. (1)

The following plants were collected by the writer on two short trips to various portions of the Green Bay peninsula, during the summer of 1897:

- a. In the upland woods, generally mesophytic localities:
 1. *Botrychium virginianum* (L.) Sudw., Baileys Harbor, Eagle Bay.
 3. *Onoclea sensibilis* L., Baileys Harbor, near Kangaroo Lake.
 5. *Pteris aquilina* L., very common everywhere on the uplands.
 12. *Unifolium Canadense* (Duf.) Greene, Egg Harbor.
 27. *Rubus parviflorus* Nutt., Baileys Harbor, Eagle Bay.
 29. *Geum canadense* Jacq., common everywhere.
 35. *Viola canadensis*, L., Egg Harbor.
 - 36, 37. *Viola rostrata*, Pursh., Egg Harbor.
 38. *Viola obliqua*, Hill., Egg Harbor.
 39. *Lepargyrea canadense* L., Greene. Common everywhere.
 41. *Circaea alpina* L., Lake Kangaroo, Eagle Bay.
 44. *Pyrola rotundifolia* L., Eagle Bay.
 45. *Pyrola secunda* L., Eagle Bay.
 52. *Prunella vulgaris* L., common throughout.
 53. *Monarda fistulosa* L. (!).
 56. *Diervilla diervilla* (L.) MacM., Baileys Harbor.
- b. In the xerophytic woodlands on the shore flats.
 11. *Lilium Philadelphicum* L., Eagle Bay, Strawberry Island.
 14. *Cypripedium hirsutum* Mill., Egg Harbor.
 - 18, 19. *Anemone canadensis* L., Fish Creek.

1. Cf. "Notes from the Green Bay Peninsula," Bull. Wis. Nat. Hist. Soc., I, April, 1900.

25. *Adlumia fungosa* (Ait.) Greene, Fish Creek.
26. *Sophia pinnata* (Walb.) Britton, Egg Harbor.
54. *Castilleja coccinea* (L.) Spreng., Strawberry Island (occurs also at Eagle Bay).
57. *Lobelia spicata* Lam., Strawberry Island.

c. On the ridge along the west shore, north of Sturgeon Bay. Pinery, until cut over some years ago; xerophytic.

5. *Pteris aquilina* L.
32. *Polygala paucifolia* Willd., Little Harbor.
55. *Pedicularis canadensis* L., Little Harbor.

d. A large part of the shore flats and the slopes leading to the uplands at Fish Creek and Egg Harbor has been cleared and become xerophytic pasture or heath. Among the species occurring here are:

61. *Achillea millefolium* L., Fish Creek.
- 59, 60. *Rudbeckia hirta* L., Fish Creek.
58. *Antennaria neo-dioica* Greene, Fish Creek.
49. *Lappula lappula* (L.) Karst., common.
50. *Verbena hastata* L., Fish Creek.
10. *Poa annua* L., the grass forming the body of these heaths. (1)
15. *Blitum capitatum* L., Fish Creek.

e. In some places, depressions in the heath show more mesophytic conditions, graduating even into marshy places. Here were found:

13. *Iris versicolor* L., Fish Creek.
21. *Ranunculus reptans intermedius* Hook., Fish Creek.
22. *Ranunculus sceleratus* L., Fish Creek.
23. *Ranunculus acris* L., Fish Creek.
51. *Scutellaria lateriflora* L., Fish Creek.

f. At Fish Creek, a brook empties into the bay. At its mouth, it broadens into a sluggish estuary. Along its course, especially towards the mouth, there is a marshy meadow. These hydrophytic stations show:

6. *Potamogeton alpinus* Balbis.
7. *Alisma plantago aquatica* L.
8. *Sagittaria latifolia* Willd.
9. *Briza media* L.
16. *Nymphaea advena* Soland.

1. *Juniperus alpina*, with its characteristic round clumps, is very characteristic of these heaths.

- 20. *Ranunculus delphinifolius* Torr.
- 24. *Roripa nasturtium* (L.) Rusby.
- 30. *Geum virginianum* L.
- 34. *Hypericum prolificum* L.
- 42. *Cicuta bulbifera* L.
- 43. *Cornus candidissima* Marsh.
- 47. *Steironema quadriflorum* Hitchc.

g. On the ledges of Limestone rock were found:

- 4. *Cystopteris bulbifera* (L.) Bernh., Fish Creek.
- 17. *Aquilegia canadensis* L., Egg Harbor.
- 31. *Geranium robertianum* L., Baileys Harbor.

h. On the sandy beach:

- 28. *Potentilla anserina* L., Fish Creek.
- 46. *Primula mistassinica* Michx., Egg Harbor.

i. On cultivated lands:

- 58. *Erigeron annuus* (L.) Pers., Fish Creek.
- 62. *Crysanthemum leucanthemum* L., Fish Creek.
- 40. *Chamaerion angustifolium* (L.) Scop., Fish Creek.
- 33. *Malva moschata* L., Baileys Harbor.

The specimens collected as above are now in the herbarium of the Public Museum of Milwaukee. The determination of the species is mostly the work of Miss Olive Wheeler of the Museum. The numbers refer to the original list in possession of the writer.

5. Forests and Brush Lands of Northern Waukesha County, Wisconsin.

The following observations refer more particularly to that part of Waukesha County lying north of the line of the Chicago & Northwestern Railway, which divides the county into two almost equal parts. It comprises therefore most of the Lake Region and the country to the east of that. The extreme west, which is really a part of the Rock River Valley, is omitted. There is no reason to believe that the southern half of the county is materially different in botanical or forestal character.

The physiography of the eastern part of the district is essentially alike to the western half of Milwaukee County: Rolling country with a subsoil of boulder clay, which allows but very few outcrops of the underlying limestone rock. Many of the gravel hills are drumloid in character, others irregular in shape. The western half is characterized by the great accumulation of morainic hills and ridges, with corresponding depressions, which is popularly known as the Kettle Range. The highest elevation of

this part of the Range is Government Hill, south of Delafield, the top of which is 368 feet over Lake Nagawicka, and 669 feet above Lake Michigan. Accompanying the moraine, and lying in part within its very center, are the numerous lakes of sizes varying from a few acres to several square miles, which have given this region fame as a summer resort. Another marked physiological feature are the many broad, level depressions, most of them evidently old lake beds. Usually there is a small river or brook of sluggish current flowing through them. Some areas of this kind have been turned into tilled fields, but the larger portion is occupied by rather moist meadows, which in many places become pronounced sedge marshes.

The forest of that part of this district lying east of the Kettle Range is on the whole similar to that of western Milwaukee County (see Bull. Wis. Natural Hist. Soc., January, 1902), except that as you proceed westward the areas in which hard maple, basswood and associated trees prevail, become rarer, and the oaks correspondingly more numerous. In other words, the mesophytic forest type, with its deep and rich humus and dense shade, gives way to the hemixerophytic oak forest, with its lighter shade and comparatively thin layer of humus. In the moist depressions, a hemi-hydrophytic association, in which the American elm is the most conspicuous member, appears just as in Milwaukee County, while portions of the larger bottoms are covered with tamarack swamps, although much of this class of land has been converted into tilled fields.

Within the oak forests, the burr oak, the most xerophytic of the group, becomes decidedly more numerous the farther west one goes.

While the eastern half of the district may still fairly be classed with Chamberlain's Oak and Maple Group (See T. C. Chamberlain, Report of Wisconsin Geological Survey, Vol. II., Chapter III.), the moment one has reached the Kettle Range, he is decidedly in the region of oak forests. Maple, basswood, butternut and white ash are practically absent. With the oaks (*Qu. alba*, *macrocarpa*, *obtusiloba*, *rubra* and *velutina*) are found *Hicoria ovata* Britton and occasionally *H. glabra* Britton. *Prunus serotina* is not uncommon, and sometimes grows to great dimensions. *Populus tremuloides* and to a less degree *P. grandidentata* are not at all infrequent, although they are more characteristic of the brush lands to be described forthwith. In tree-form, these two species seem to prefer situations that are not too dry, as for instance at the bottom of a slope, the higher portions of which are left in the possession of the oaks.

In the Kettle Range the traveler coming from Lake Michigan

meets for the first time with *Juniperus virginiana*. The red cedar trees are nearly all comparatively young, and usually occupy places where the oak forest has been removed and a heath taken its place. In this region, also, the first traces of the peculiar formation locally known as "openings," are met with. These savanna-like areas are, or were before settlement, very conspicuous features of the Rock River Valley and the territory to the west and south. An area of this kind of small extent, is found on the east side of Lower Nemahbin Lake. On a steep slope with western exposures grow about fifty old burr oaks. None are higher than twenty feet, those at the uppermost places being the smallest. Their average diameters are about twelve inches. They branch very low and have broad, spreading crowns. Notwithstanding their small size it is evident from their bark and general appearance that they are very old. They stand so far apart that their branches do not touch. The ground is covered with a dense sward of *Poa*, which in 1901 had the upper third of the slope exclusively to itself, aside from a few insignificant patches of a small moss that is usually found on *Poa* heaths. Farther down hill, there were colonies of *Antennaria plantaginifolia* and *Hedeoma pulegioides*. The latter was most conspicuous in spots where dry leaves had accumulated and driven off the grass. Here were also a few seedlings of *Populus tremuloides* and *Juniperus virginiana*. At the foot of the hill, immediately on the water's edge, there are a few basswood and American elm trees, with several seedlings. The northern slope of this hill has instead of the opening the hemixerophytic thicket commonly found in similar localities. The opening here described is not a typical one. Usually the oaks are of considerable size, while here they show decided dwarfishness. Apparently the steepness of the slope together with the westerly exposure, which cause long and powerful insolation, have made the conditions of life exceedingly hard here. But the arrival of seedlings of aspen and cedar undoubtedly foreshadows the future conversion of even this unfavorable locality into a thicket such as is found on the north side of the hill.

Like all of the southeastern portions of Wisconsin, the district under discussion shows very great traces of the influence of man. The almost continuous forest originally covering the land has been cleared away, until now only isolated patches remain. The hilly character of the Kettle Range country has preserved a larger portion of that part of the territory under forest cover than is the case towards the east. But even here many steep slopes, quite unfit for agriculture, have been denuded. On such slopes a succession of formations takes place, very similar to the history of like areas in Milwaukee County as described above, yet differing

in many details, agreeably to the more xerophytic character of the flora.

In many places, the forest has given way altogether to a *Poa* heath. This is probably the normal case whenever the tree cover is entirely removed, unless there is an opportunity for coppice growth. The latter is more or less of an accident, as the small farmers who own the land rarely regulate their cutting with this end in view. Mesophytic thickets of witch hazel and its associates, such as are common farther east, seem to be absent in Waukesha County. Even north and east exposures become *Poa* heaths with hemixerophytic shrubs, and the only difference between them and south or west slopes seems to be, that in the latter the progress from heath to thicket is a little faster.

Among the shrubs that are most conspicuous in the early stages of a heath are hazelnut, several species of hawthorn, and the staghorn sumach. Later come choke cherries, wild plums, and crab apple. On the Kettle Range, clumps of red cedar are a prominent feature of these localities. They do not seem to be able to thrive in thickets, however, and therefore disappear, when the later stages are reached. The trembling aspen takes little part in the early development of a heath. But by the time the various groups of hawthorn and hazel begin to run together, it appears and multiplies very rapidly; often it drives out its predecessors. The aspen is enabled to do so, because it spreads by root suckers; plants that send out many of these, remain shrubby instead of assuming tree form like their brethren in the forest. After a thicket of this kind has grown to be rather dense, a considerable accumulation of humus may take place and much more mesophytic conditions be produced. This shows itself at once in the character of the herbs covering the soil.

As long as the heath character is still pronounced, few foreign species are found in the *Poa* sward. Among these few are *Ranunculus fascicularis*, *Viola pedata* (apparently not found east of the Kettle Range), *Verbascum thapsus*, *Antennaria plantaginifolia*, and the ever-present dandelion. The incipient thickets harbor *Viola sororia*, *Anemone nemorosa*, *Anemone nuttalliana*, *Fragaria*. When the thicket becomes quite dense, one may find *Viola obliqua*, *Ranunculus abortivus*, *Hepatica*, *Podophyllum peltatum*, and now and then even so distinctively a mesophytic herb as *Trillium grandiflorum*. By the time this stage is reached, numerous young oaks, hickories and black cherries have usually appeared, which gradually overtop the shrubs, so that the latter thereafter form the underwood in an oak forest. It appears, therefore, that the most mesophytic stations in this region are not the forests, but the thickets which precede them.

As a rule the reclaiming of a heath begins at the foot of a hill, so that the lower portion may already show young oak forest, while the top is still typical *Poa* heath. Sometimes it happens that the top of the hill is broad and level. It may be either a tilled field or a forest. In either case the top may form a base of attack for the invading shrubs (in case of a field, there is usually a fence-row, from which they may spread), so that a thicket may form both at the foot and the top of the slope, while the middle portion is still grassland.

Mesophytic stations, such as are afforded by the maple-basswood forests in Milwaukee County, are rather rare in Waukesha. Consequently the species characteristic of such localities do not form a conspicuous feature of the flora. Such plants as *Erythronium Americanum*, *Viola pubescens*, *Trillium grandiflorum*, and other herbs with very few or no xerophytic adaptations are most apt to be found here in moist depressions, where the elm is the significant tree. *Podophyllum peltatum* has already been mentioned as occurring in the older portions of the thickets described. It is rare in the oak forests, except in places where very dense underbrush has allowed unusually rich humus to accumulate. It is quite common, on the other hand, along fence rows, which here as in Milwaukee County are distinguished by a remarkably comprehensive flora. A very interesting occurrence of *Podophyllum* is sometimes found in deep and narrow "kettles," where the forest has been cleared or strongly thinned. Here one can sometimes find the floor generally covered with grass. In the bottom is an accumulation of dry leaves which prevents the grass from growing. Here are numerous plants of *Podophyllum*, which also spreads about half way up the southern slope. On the opposite side of the kettle, which receives the noon-day sunshine, not a single mandrake will be seen, but instead there grow among the grass colonies of such xerophytic plants as *Antennaria* and *Viola sororia*.

On the whole, it is apparent, that the oak forest has a fair prospect of returning to the places from which it was removed, when the cycle of heath and thicket is complete. Here and there, however, one may observe very dense and old thickets, in which the trees are quite absent. This is especially so, where the crab apple is the predominant species. As the oak is decidedly intolerant of shade, it may be that the thicket in such cases is too dense to allow seedlings to grow up. Another reason, of course, may be simply the absence of seed, as the heavy fruits of oaks and hickories do not travel far. One might conceive a case, under such circumstances, where basswood and maple might find a place under the shrubs, as they are certainly tolerant enough of

shade to prosper in such places. Then the thicket would be followed directly by the culmination type of forest. No actual case of this kind has, however, been observed, so far. Generally speaking, the advent of man has made it more difficult, rather than otherwise, for the forest of the region to progress to its culmination in the maple-basswood-beech association, for reasons given at length in the paper on Milwaukee County.

6. Eastern Wisconsin Plants from the Herbarium of the Milwaukee Public Museum.

The herbarium of the Public Museum of the City of Milwaukee contains some excellent material, and with proper attention may in the future grow into a collection of considerable value. It now numbers over 10,000 sheets, and is divided into Wisconsin, United States and foreign (mostly Central European) material. Aside from a collection of mosses, mostly from Europe, only the Spermatophytes and Pteridophytes are represented. (Within the last two years, a collection of fungi has been started and is rapidly growing).

The Wisconsin department, as, in fact, practically the whole herbarium, has grown up, as it were, by accident. That is, various private collectors have from time to time contributed material. This has been arranged simply by placing each sheet in its proper genus cover. The Wisconsin genera lie in their case according to families, but for the rest of the collection, even so much has not yet been done. As might be expected under these circumstances, the herbarium shows great gaps; as is usual with amateur collectors, the most common and characteristic species of a given locality are often absent, while there is a fair proportion of "rarities." The determinations have usually been made by the collectors themselves, and as a result great confusion exists regarding the nomenclature, in which, however, Gray's Manual seems to have been followed most often. Unfortunately some of the collectors have deemed it unnecessary to add the authority for the name given to a plant, which increases the confusion. In the following list no attempt is made to reduce the nomenclature to a modern standard, but the name is reproduced as found on the specimen sheet. The determinations seem to be correct, on the whole. There may be some errors, especially in the more difficult genera and families, but not enough to impair the value of the following list, such as it is. Another unfortunate defect in the herbarium is the scantiness of the field notes, which made it quite impossible to attempt a classification of the species according to the character of their habitat.

The question may arise whether it is worth while to publish such fragmentary lists as are given below. The answer is that so very little is known regarding the local distribution of Wisconsin plants (1) that even the scantiest data are a help to the student. It is devoutly to be wished that a more systematic study may soon be undertaken by competent authority, so that such work as this may be entirely superseded.

The majority of the plants in the Milwaukee herbarium come from Milwaukee county. Of these full lists have already been published. There are some sheets with plants coming from many scattered parts of the state, but not enough from any one locality to make a useful list. These have been omitted. The lists printed below refer therefore to portions of Eastern Wisconsin, *i. e.*, that part lying between Lake Michigan on the east and the Fox-Rock River Valley on the west. The only exception is the list referring to the vicinity of the Dells of the Wisconsin, which is in the central portion of the state.

The numbers added are the regular accession numbers of the Milwaukee herbarium.

A. JEFFERSON COUNTY.

The region covered by this list lies in the broad valley of the Rock River. It was originally debatable ground between oak forest, opening and prairie, with large stretches of sedge marsh and tamarack swamp. At present most of the area is under cultivation or in pasture. There are numerous brooks and a large body of water known as Lake Koshkonong, besides smaller lakes and ponds.

The plants in this list were collected by T. Kumlien, unless otherwise noted. Mr. Kumlien's work was mostly done forty and more years ago, so that some of his species have probably disappeared from the locality.

- 1230. *Pellaea atropurpurea* Gr.
- 1047. *Najas flexilis* Rost.
- 7062. *Scheuchzeria palustris* L.
- 1063. *Triglochin maritimum* elatum.
- 1064. *Alisma plantago americanum* (dwarf specimens).
- 931. *Vallisneria spiralis* L.
- 1171. *Panicum capillare* L. (?)
- 1129. *Bouteloua curtipendula* Gray.
- 1106. *Cyperus filiculmis* Vahl.

1. See L. S. Cheney, *Historical Review of Work Done on the Flora of the Territory now Included in the Limits of Wisconsin*. *Pharmaceutical Review*, Vol. XVIII, 12; XIX, 1.

1098. *Cyperus diandrus* var. *castaneus* Torr.
1100. *Cyperus Michauxianus* Schultes.
1101. *Cyperus Engelmanni* Stend.
1105. *Cyperus inflexus* Muhl.
1108. *Eleocharis obtusa* Schultes.
1119. *Scirpus americanus* Pers.
1111. *Eriophorum virginicum* L.
961. *Liparis liliifolia* Richard.
933. *Calopogon pulchellus* R. Br.
870. *Betula pumila* L.
863. *Alnus incana* Willd. (?)
850. *Pilea pumila* Gray.
826. *Asarum Canadense* L.
52. *Nelumbium luteum* Willd. (In lake between Bussey-
ville and Albion, Dane County, 1850).
12. *Coptis trifolia* Salisb.
7. *Hepatica triloba* Chaix.
65. *Dicentra cucullaria* D. C.
63. *Corydalis aurea* Willd.
68. *Arabis dentata* Torr. and Gray.
79. *Draba Caroliniana* Walt.
302. *Drosera rotundifolia* L.
303. *Drosera linearis* Goldie.
244. *Geum triflorum* Pursh.
185. *Amorpha fruticosa* L.
205. *Lathyrus palustris* L.
1114. *Hemicarpha micrantha* Vahl.
1116. *Rhynchospora alba* Vahl.
1083. *Carex limosa* L.
1087. *Carex stellulata*
1025. *Juncus tenuis* Willd.
1028. *Luzula pilosa* Willd.
1042. *Lemna trisulca* L. (?)
1043. *Lemna polyrhiza* L. (?)
1013. *Pontederia cordata* L.
1015. *Schollera dubia*.
914. *Cypripedium candidum*, Muhl.
954. *Platanthera flava* Gray.
955. *Platanthera leucophaea*, Nutt.
957. *Habenaria lacera* R. Br.
965. *Pogonia ophioglossoides* Nutt.
966. *Pogonia pendula*, Lindl.
932. *Arethusa bulbosa* L.
945. *Goodyera pubescens* R. Br.
962. *Microstylis ophioglossoides*, Nutt.

108. *Polygala verticillata* L.
103. *Polygala incarnata* L. (1)
104. *Polygala sanguinea* L.
105. *Polygala cruciata* L.
832. *Acalypha virginica* L.
183. *Rhus venenata* D. C.
134. *Hypericum mutilum* S.
95. *Viola sagittata* Ait.
315. *Epilobium lineare* Muhl.
316. *Epilobium molle* Torr.
320. *Oenothera pumila* L.
306. *Hippuris vulgaris* L.
600. *Cassandra calyculata* Dow.
648. *Gentiana puberula* Michx.
655. *Ellisia Nyctelia* L.
737. *Verbena stricta* Vent.
739. *Verbena bracteosa* Michx.
731. *Lippia lanceolata* Michx.
750. *Lophanthus nepetoides* Benth.
716. *Verbascum blattaria* L.
702. *Mimulus Jamesii* Torr. and Gray.
697. *Ilysanthes gratioloides* Benth.
713. *Synthyris Houghtoniana* Benth.
696. *Gerardia quercifolia* Pursh.
695. *Gerardia tenuifolia* Vahl.
727. *Utricularia vulgaris* L.
229. *Utricularia clandestina* Nutt. (?)
403. *Valeriana ciliata* Torr. and Gray. (2)
522. *Hieracium canadense* Michx.
525. *Kuhnia eupatorioides* L.
533. *Liatris cylindracea* Michx.
9957. *Solidago neglecta* (C. E. Monroe.)
9242. *Solidago rigidiuscula* (C. E. Monroe.)
9224. *Solidago nemoralis* (Monroe.)
9229. *Solidago Canadensis* (Monroe.)
490. *Erigeron bellidifolium* Muhl.
494. *Erigeron strigosum* Muhl.
493. *Erigeron annuum* Pers.
425. *Diplopappus linariifolius* Hook.
552. *Silphium integrifolium* Michx.
9320. *Aster longifolius* (Monroe.)
9315. *Aster novi-Belgii* (Monroe.)

1. Date 1860; marked "now exterminated."

2. Date 1856; marked "long since extinct in that locality," (one mile west of Busseyville).

- 9336. *Aster laevis* (Monroe).
- 9321. *Aster paniculatus* (Monroe).
- 9305. *Ionactis linariifolius* (Monroe).
- 456. *Aster amethystinum* Nutt.
- 457. *Aster oblongifolius* Nutt.
- 9361. *Aster sericeus* (Monroe).
- 518. *Helianthus hirsutus* Raf.

B. WAUKESHA COUNTY.

The plants listed from this county are all derived either from the "Lake Region," which includes the gravel hills of the Kettle Range, or the rolling country to the east of the latter. The area was, therefore, mostly wooded before settlement, with but few and inconsiderable prairies.

The specimens were collected by C. E. Monroe, unless otherwise noted (1) :

- Panicum porterianum* Nash. A. Conrath.
- 1157. *Koeleria cristata* Pers. Conrath.
- 1152. *Glyceria nervata* Trinius. Conrath.
- 1074. *Carex intumescens* Rudge. Conrath.
- 967. *Spiranthes cernua* Rich. Conrath.
- 9667. *Polygonum dumetorum*.
- 9403. *Ranunculus trichophyllus*. Nagawicka.
- 9404. *Ranunculus Pennsylvanicus*.
- 9415. *Lepidium Virginicum*.
- 301. *Drosera rotundifolia* L. (?) W. M. Wheeler.
- 284. *Heuchera hispida* Pursh. Conrath.
- 9874. *Spiraea salicifolia*.
- 9880. *Rubus Canadensis* L.
- 9889. *Potentilla norwegica*.
- 253. *Potentilla fruticosa* L., Genesee. W. M. Wheeler.
- 255. *Potentilla palustris* Scapoli. Conrath.
- 189. *Apios tuberosa* Moench. W. M. Wheeler.
- 9454. *Rhus hirta* Sudw. Conrath.
- 9119. *Apocynum cannabinum*.
- 1054. *Potamogeton compressus* L. Conrath.

1. Mr. Bruncken's complaint of unnecessary confusion caused by the omission of the authorities from these names is only partly justified. When my private collection was turned over to the Public Museum some six years ago it was with the statement that the names and their authors were those found in the Revised Edition of Gray's Manual of Botany of 1890. The names given in the foregoing list and in the following lists of plants from Racine County and the Dells of the Wisconsin do not seem to be in all cases those which were written upon the original sheets, some revision having apparently been made after the publication of Britton & Brown's work on the Flora of the United States. In addition to the specimens collected and donated to the Public Museum a large number of Species are listed in my note books from localities in Waukesha and Racine Counties and the Dells of the Wisconsin.—CHARLES E. MONROE.

1055. *Potamogeton praelongus* Wulf. Conrath.
1052. *Potamogeton pusillus* L. Conrath.
1123. *Agrostis perennis* Tuckerm. Conrath.
1181. *Poa alsodes* Gray.
1151. *Glyceria elongata* R. Br.
..... *Juncus tenuis* Willd.
9663. *Corallorhiza multiflora*.
809. *Polygonum amphibium* L.
9684. *Polygonum Careyi*. New Berlin.
9669. *Polygonum dumetorum*.
9698. *Polygonum lapathifolium*.
9680. *Polygonum persicaria*.
9696. *Polygonum aviculare*.
51. *Brasenia purpurea* Casp. Muskego Lake, Bruhin.
9390. *Clematis virginiana*.
9405. *Ranunculus Pennsylvanicus*.
9465. *Trifolium hybridum*.
212. *Petalostemon violaceum* Michx. W. M. Wheeler.
9432. *Desmodium nudiflorum*.
9707. *Euphorbia corollata*.
9449. *Ceanothus americana*.
9433. *Hypericum maculatum*.
9432. *Hypericum perforatum*.
9431. *Hypericum Ascyron*.
9438. *Triadenum Virginicum* Raf.
9926. *Isnardia palustris*.
9925. *Ludwigia polycarpa*.
9929. *Epilobium coloratum*.
9935. *Epilobium adenocaulum*.
9103. *Asclepias tuberosa*.
9109. *Asclepias cornuti*.
9106. *Asclepias purpuraceus*.
9208. *Calystegia saepium*.
653. *Phlox pilosa* L.
9214. *Echinosperrum Lappula*.
9215. *Echinosperrum virginicum*.
9162. *Verbena hastata*.
9137. *Scutellaria versicolor*.
9135. *Scutellaria lateriflora*.
9139. *Lophanthus scrofulariaefolius*.
9138. *Nepeta cataria*.
9133. *Prunella vulgaris* L.
9131. *Stachys palustris*.
741. *Blephilia ciliata* Raf. Conrath.
9142. *Hedeoma pulegioides*.

769. *Pycnanthemum lanceolatum* Pursh. Runge.
9194. *Lycopus virginicus*.
9152. *Mentha Americana*.
685. *Physalis Pennsylvanica* L. Conrath.
9201. *Scrophularia nodosa*.
9180. *Gerardia purpurea paupercula*.
9181. *Gerardia purpurea*.
9157. *Phryna leptostachya*.
9042. *Cephalanthus occidentalis*.
9046. *Galium boreale*.
9038. *Symphoricarpus racemosus*.
9076. *Campanula Americana*.
9073. *Campanula rotundifolia*.
9057. *Lobelia Cardinalis*.
9069. *Lobelia Kalmii*.
10118. *Lactuca canadensis*.
10014. *Eupatorium perfoliatum*.
10012. *Eupatorium purpureum*.
10023. *Liatris scariosa*.
532. *Liatris cylindracea*. W. M. Wheeler.
9243. *Solidago Missouriensis*.
9957. *Solidago rigida*.
9961. *Solidago neglecta*.
9990. *Solidago serotina*.
10058. *Heliopsis scabra*.
10057. *Heliopsis helianthoides*.
10053. *Silphium perfoliatum*.
10046. *Polymnia canadensis*.
10043. *Inula Helenium*.
10041. *Gnaphalium polycephalum*.
9317. *Aster junceus*.
10061. *Rudbeckia laciniata*.
10075. *Lepachys columnaris*.
10070. *Lepachys pinnata*.
10076. *Coreopsis palmata*.
458. *Bidens cernua* L. (var. ?). W. M. Wheeler, Muskego
Lake.

C. TWO RIVERS.

There is a considerable collection from the neighborhood of Two Rivers, Manitowoc County, contributed by Prof. Emil Dapprich, unless another name is given.

7711. *Equisetum scirpoides* Michx. E. Dapprich.
7963. *Potamogeton compressus* L. E. Dapprich.
7967. *Potamogeton pusillus* L. E. Dapprich.

7966. *Potamogeton pauciflorus* Pursh. E. Dapprich.
8036. *Potamogeton pectinatus* L. E. Dapprich.
7964. *Potamogeton natans* L. E. Dapprich.
7960. *Potamogeton praelongus* Wulf. E. Dapprich.
7961. *Potamogeton heterophyllus* Fries. E. Dapprich.
7971. *Zostera marina* L. E. Dapprich.
8035. *Triglochin palustre* L. E. Dapprich.
8026. *Sagittaria variabilis gracilis* Eng. E. Dapprich.
8032. *Sagittaria heterophylla* Pursh.
8025. *Anacharis Canadensis* Planch.
8339. *Deyeuxia confinis* Kunth.
8135. *Juncus Balticus* Dethard.
8136. *Juncus filiformis* L.
1005. *Tofieldia glutinosa* Willd. Th. Kumlien.
8022. *Calla palustris* L.
8152. *Clintonia borealis* Raf.
8151. *Smilacina stellata* Desf.
8155. *Trillium erectum album* Pursh.
8119. *Habenaria obtusata* Richards.
8112. *Microstylis monophyllos* Lindl.
8110. *Liparis Loeselii* Richard.
6823. *Myrica Gale* L.
7053. *Populus balsamifera candicans* Gray.
6817. *Betula pumila* L.
6815. *Betula lutea*.
6816. *Betula papyracea* Ait.
6818. *Alnus incana* Willd.
7037. *Polygonum erectum* L.
7178. *Stellaria longipes* Goldie.
8185. *Arenaria stricta* Watson.
6573. *Nymphaea tuberosa* Paine.
6796. *Ceratophyllum echinatum*.
6592. *Ranunculus Cymbalaria* Pursh.
6539. *Ranunculus Pennsylvanicus* L. F.
26. *Ranunculus ovalis* Raf.
29. *Ranunculus Pennsylvanicus* L. F.
30. *Ranunculus fascicularis* Muhl.
67. *Arabis lyrata* L. Kumlein.
6610. *Dentaria maxima* Nutt.
6606. *Cardamine pratensis* L.
6596. *Brassica campestris* L.
6566. *Cakile Americana* L.
6565. *Cakile maritima* Scop.
6572. *Sarracenia purpurea* L.
7736. *Chrysosplenium Americanum* Schw.

7734. *Sedum acre* L.
7742. *Ribes gracile* Michx.
7743. *Ribes floridum* L'Her.
7744. *Ribes prostratum* L'Her.
7548. *Rubus Canadensis* L.
7530. *Potentilla palustris* Scop.
7558. *Prunus pumila* L.
6898. *Lupinus Nootkaensis* Donn.
7157. *Polygala paucifolia* L.
7297. *Euphorbia polygonifolia* L.
7306. *Euphorbia glyptosperma* Englm.
8330. *Callitriche verna* L.
8329. *Callitriche terrestris*.
7192. *Ilex glabra* Gray.
7140. *Acer spicatum* Lam.
7112. *Hypericum ellipticum* Hook.
7591. *Epilobium palustre albiflorum*.
7574. *Proserpinaca palustris* L.
351. *Aralia spinosa* L. Kumlien.
7682. *Cornus stolonifera* Michx.
7395. *Pyrola asarifolia* Hook.
7384. *Vaccinium Pennsylvanicum* Lam.
8232. *Vaccinium Oxycoccus* L.
7382. *Arctostaphylos Uva-ursi* L.
604. *Epigaea repens* L. Kumlien.
7387. *Andromeda polifolia* L.
7388. *Cassandra calyculata* Don.
7380. *Chiogenes hispidula* T. and G.
617. *Androsace occidentalis* Pursh. (?) Kumlien.
7408. *Lysimachia nummularia* L.
7276. *Gentiana Andrewsii* Griseb.
7271. *Halenia deflexa* Griseb.
7482. *Menyanthes trifoliata* L.
7882. *Phacelia Franklinii* Gray.
7791. *Stachys aspera* Michx.
7405. *Utricularia intermedia* Hayne.
7997. *Galium asprellum* Michx.
7996. *Galium boreale* L.
7995. *Galium triflorum* Michx.
7994. *Galium trifidum* L.
7974. *Viburnum Opulus* L.
7983. *Symphoricarpus vulgaris* Michx.
7980. *Symphoricarpus occidentalis* Michx.
7979. *Lonicera hirsuta* Eaton.
596. *Campanula rotundifolia* L.

- 7511. *Hieracium Gronovii* L.
- 7512. *Hieracium Canadense* Michx.
- 8224. *Chrysocoma tomentosa* Walt.
- 6222. *Eupatorium maculatum* Darl.
- 6984. *Solidago hispida*.
- 6217. *Erigeron glabellus* Nutt.
- 6727. *Gnaphalium uliginosum* L.
- 6202. *Aster novi-Belgii praealtus* Lam.
- 7219. *Aster macrophyllus* L.
- 7762. *Hyssopus officinalis* L.
- 6774. *Helianthus scaberrimus* Nutt.
- 6766. *Coreopsis grandiflora* Nutt.
- 6765. *Coreopsis lanceolata* L.
- 6792. *Bidens Beckii* Torr.
- 6735. *Achillea ptarmica* L.
- 7506. *Cnicus Pitcheri* Torr.
- 7503. *Cnicus muticus* Pursh.

D. RACINE COUNTY.

The following specimens, mostly from either the Town of Mount Pleasant or that of Yorkville, were contributed by C. E. Monroe, unless otherwise noted.

- 9614. *Allium cernuum*. Yorkville.
- 9626. *Habenaria leucophaea*. Yorkville.
- 9657. *Gyrostachys cernua*. Mount Pleasant.
- 9686. *Polygonum Hartwrightii*. Yorkville.
- 9679. *Polygonum hydropiperoides*. Mt. Pleasant.
- 9426. *Silene stellata*. Yorkville.
- 9424. *Saponaria officinalis*. Mt. Pleasant.
- 9392. *Anemone cylindrica*. Yorkville.
- 9397. *Anemone virginiana*. Yorkville.
- 9916. *Heuchera hispida*. Yorkville.
- 9514. *Cassia chamaecrista*. Yorkville.
- 9461. *Baptisia leucophaea*. Mt. Pleasant.
- 9468. *Trifolium procumbens*. Mt. Pleasant.
- 9470. *Amorpha canescens*. Yorkville.
- 9473. *Kunistera candida*. Yorkville.
- 9491. *Desmodium Dillenii*. Yorkville.
- 9499. *Vicia americana linearis*.
- 9502. *Lathyrus palustris*.
- 9459. *Polygala viridescens*. Mt. Pleasant.
- 9173. *Gerardia tenuifolia*.
- 9183. *Gerardia purpurea*. Mt. Pleasant.
- 9188. *Gerardia auriculata*. Mt. Pleasant.

9029. *Sambucus Canadensis*. Mt. Pleasant.
9062. *Lobelia spicata*.
10113. *Prenanthes racemosa*. Mt. Pleasant.
10031. *Boltonia asterioides*. Mt. Pleasant.
10025. *Liatris scariosa*. Mt. Pleasant.
10029. *Liatris spicata*. Yorkville.
..... *Solidago Missouriensis*. Mt. Pleasant.
9222. *Solidago Ohioensis*. Mt. Pleasant.
9221. *Solidago Riddellii*. Mt. Pleasant.
9954. *Solidago rigida*. Mt. Pleasant.
9231. *Solidago serotina*. Mt. Pleasant.
9225. *Solidago nemoralis*. Mt. Pleasant.
9997. *Solidago canadensis*. Mt. Pleasant.
9976. *Solidago juncea*. Mt. Pleasant.
10054. *Parthenium integrifolium*. Yorkville.
10051. *Silphium integrifolium*. Yorkville.
10050. *Silphium terebinthinaceum*. Yorkville.
9705. *Euphorbia nutans*.
9923. *Lythrum alatum*.
9869. *Pastinaca sativa*.
9854. *Eryngium aquaticum*. Yorkville.
9863. *Berula erecta*. Mt. Pleasant.
9865. *Sium cicutaeifolium*. Mt. Pleasant.
9859. *Zizia cordata*.
9857. *Cicuta maculata*.
9127. *Gentiana puberula*. Mt. Pleasant.
9110. *Asclepias Sullivantii*.
9102. *Asclepias tuberosa*. Yorkville.
9115. *Acerates viridiflora*. Yorkville.
9114. *Acerates longifolia*. Yorkville.
9116. *Acerates lanuginosa*. Yorkville.
9218. *Phlox pilosa*.
9211. *Lithospermum canescens*.
9144. *Pycnanthemum linifolium*. Yorkville.
9146. *Pycnanthemum lanceolatum*. Yorkville.
9150. *Mentha Canadensis*. Yorkville.
10048. *Silphium laciniatum*. Yorkville.
9360. *Aster novae-angliae*. Mt. Pleasant.
9333. *Aster multififormis*. Mt. Pleasant.
9304. *Aster ptarmicoides*. Mt. Pleasant.
9367. *Aster azureus*. Mt. Pleasant.
10073. *Lepachys pinnata*. Yorkville.
9262. *Helianthus Maximiliani*. Mt. Pleasant.
10101. *Cnicus altissimus*. Yorkville.

E. PORT WASHINGTON.

The neighborhood of Port Washington, Ozaukee County, furnishes the following specimens, collected by F. Runge, unless stated otherwise:

- 1221. *Struthiopteris Germanica* Willd.
- 1219. *Cystopteris bulbifera* Berut.
- 1207. *Aspidium spinulosum* Swartz.
- 1231. *Phegopteris Dryopteris* Fee.
- 928. *Pinus Strobus* L.
- 921. *Juniperus communis* L.
- 866. *Betula lenta* Linn.
- 22. *Ranunculus acris* L.
- 299. *Penthorum sedoides* L. Cedarburg.
- 277. *Spiraea salicifolia* L. C. Doerflinger, Cedarburg.
- 249. *Potentilla palustris* Scop. C. Doerflinger, Cedarburg.
- 265. *Rosa rubiginosa* L. Cedarburg.
- 264. *Rosa blanda* Ait.
- 197. *Desmodium Canadense* D. C.
- 188. *Amphicarpaea monoica* Nutt.
- 6314. *Acer spicatum* Lan. Lake Shore.
- 138. *Malva moschata* L.
- 6309. *Dirca palustris* L.
- 828. *Shepherdia Canadensis* Nutt.
- 360. *Cornus circinata* L.
- 610. *Pyrola chlorantha* Schwart.
- 599. *Arctostaphylos Uva-Ursi* Spreng. Lake Shore.
- 772. *Satureia hortensis* L.
- 682. *Lycium vulgare* Dunal.
- 384. *Viburnum dentatum* L. Lake Shore.
- 366. *Lonicera hirsuta* Eaton.
- 527. *Lactuca canadensis sanguinea* T. and G.
- 556. *Solidago serotina* Ait. Lake Shore.
- 512. *Helianthus giganteus* L.
- 509. *Helianthus mollis* Lam.
- 417. *Artemisia Absinthium* L.

F. ELKHART LAKE.

Mr. A. Conrath has contributed the following small but interesting list, mostly from the tamarack swamps in the vicinity of Elkhart Lake, Sheboygan County:

- 923. *Juniperus Virginiana* L.
- 968. *Spiranthes cernua* Richard.
- 601. *Chimaphila umbellata* Nutt.
- 605. *Gaultheria procumbens*.

- 607. *Ledum latifolium* Ait.
- 602. *Chiogenes hispidula* Torr. and Gray.
- 770. *Pycnanthemum pilosum* Nutt.
- 593. *Lobelia Kalmii* L.
- 521. *Hieracium canadense* Michx.
- 447. *Aster puniceus* L.
- 444. *Aster ptarmicoides* T. and G.
- 424. *Ionactis linariifolius*.

G. CEDAR LAKE.

Cedar Lake in Washington County contributes the following by W. M. Wheeler:

- 6342. *Equisetum limosum* L.
- 6339. *Corydalis glauca* Pursh.
- 6343. *Corallorhiza multiflora* Nutt.
- 6340. *Arabis Drummondi* Gray. (?)
- 213. *Petalostemon violaceum* Michx. Conrath.
- 6344. *Circaea alpina* L.
- 6338. *Pyrola secunda* L.
- 9096. *Monotropa uniflora* L.

H. DELLS OF THE WISCONSIN.

Mr. C. E. Monroe contributes the following from the neighborhood of Kilbourn City and the Dells above and below that place:

- 9628. *Habenaria Hookeriana*.
- 9642. *Limodorum tuberosum*.
- 816. *Polygonum Virginianum* L.
- 9678. *Polygonum hydropiper*.
- 9412. *Corydalis glauca*.
- 9914. *Sullivantia Sullivantii*.
- 9892. *Potentilla argentea*.
- 9462. *Baptisia leucantha*.
- 9467. *Trifolium hybridum*.
- 9487. *Desmodium acuminatum*.
- 9481. *Desmodium nudiflorum*.
- 9457. *Polygala viridescens*.
- 9709. *Euphorbia helioscopia*.
- 9702. *Euphorbia humistata*. Portage.
- 9701. *Euphorbia glyptosperma*. Portage.
- 9435. *Hypericum gymnanthum* Engelm.
- 9437. *Hypericum Canadense*.
- 9422. *Lechea minor*.
- 9927. *Epilobium lineare*.

9936. *Epilobium Hornemanni*.
9944. *Epilobium hirsutum*.
9947. *Kneiffia pumila*.
9940. *Onagra Oakesiana*.
9943. *Oenothera rhombipetala*.
9080. *Gaultheria procumbens*.
9213. *Echinosperrnum Lappula*.
9212. *Lithosperrnum hirtum*.
9141. *Monarda punctata*.
9189. *Gerardia grandiflora*.
9191. *Gerardia pedicularis*.
9178. *Gerardia tenuifolia*.
526. *Mulgedium leucophaeum* D. C.
10107. *Hieracium canadense*.
10109. *Hieracium scabrum*.
10015. *Eupatorium ageratoides*.
10026. *Liatris pycnostachya*.
10024. *Liatris scariosa*.
10018. *Liatris cylindracea*.
9960. *Solidago uliginosa*.
9239. *Solidago speciosa*.
9245. *Solidago hispida*.
9996. *Solidago Canadensis*.
9223. *Solidago juncea scabella*.
9307. *Doellingeria umbellata*.
10042. *Gnaphalium uliginosum*.
9293. *Helianthus giganteus*.
9253. *Helianthus occidentalis*.
9263. *Helianthus Maximiliani*.
10090. *Helenium autumnale*.
10103. *Cnicus muticus*.

It may be permitted to add here a list of the ferns growing in or near the Dells according to Miss H. B. Merrill, as stated by her in a little pamphlet published by the Chicago, Milwaukee & St. Paul Railway Company: (1)

- Adiantum pedatum*.
Dryopteris cristata.
Dryopteris fragrans.
Dryopteris marginalis.
Dryopteris spinulosa.
Dryopteris Thelypteris.
Asplenium Filix-foemina.

1. Ferns of the Dells of the Wisconsin at Kilbourn City, Wis., on the line of the Chicago, Milwaukee & St. Paul Railway Co. Published for the General Passenger Department.

Asplenium acrostichoides.
Asplenium Trichomanes.
Botrychium ternatum.
Botrychium Virginianum.
Camptosorus rhizophyllus.
Cystopteris bulbifera.
Cystopteris fragilis.

The most interesting of these ferns is *Dryopteris fragrans*, on account of its rarity, it being known to occur in but very few and widely separated places. This list is by no means complete.

7. A Tamarack Swamp in Waukesha County.

The little hamlet of Calhoun, on the Northwestern Railway, in the northern part of the town of New Berlin, Waukesha County, lies near the eastern extremity of one of those broad depressions, the beds of lakes within very recent times, which are so common in the eastern part of that county. The drainage of this depression, such as there is, goes towards the Fox River (of the Illinois). The width of the basin is about a mile, and the length from east to west about two miles. The central part of the basin constitutes a paludinal area, which ranges from places with open, shallow water and a flora dominated by *Typha*, through various grades of sedge marsh to mesophytic meadow land. The boundaries of these various zones are rather indefinite and vary from time to time, according as there is a succession of wet or dry seasons. They exhibit a wealth of *Cyperaceae*, *Gramineae* and other grass-like forms, and will richly repay a closer study, which, however, must be left to a future time.

Surrounding the grass area is an irregular, much interrupted belt of hydrophilous shrubbery. The dominant genus in this association is *Salix*. The most conspicuous species of willow is a form very similar to the typical *Salix sericea* of the Eastern states. Associated are *S. discolor*, *S. lucida*, *S. candida*, and probably several others, not to speak of hybrids. Mingled with the willows are several species of *Cornus*, *Spiraea salicifolia*, and in some places *Viburnum* (especially *V. Lentago*); and in the driest parts *Sambucus Canadensis*. Of herbaceous species growing in the shade of these shrubs, various species of *Polygonum*, *Impatiens fulva*, *Cardamine rhomboidea* are among the most conspicuous.

A form of *Betula* is found in these saliceta, which combines some of the characteristics of *B. glandulosa* Michx. and *B. pumila* L. Like the former its branchlets, even the youngest, and leaves are entirely glabrous; the fruit catkins are oval, or rather club-shaped; it does not grow higher than about five feet, and its leaves

are but slightly paler on the lower side. On the other hand, there are no distinct glandular warts on the twigs, and the veins are conspicuously reticular on both sides of the leaves, as in *B. pumila*. A form in which just the opposite characters are similarly mingled, that is tall shrubs with pubescent shoots like *pumila*, and conspicuous glandular warts like *glandulosa*, occurs in the Menomonee valley near Milwaukee.

The salicetum is rapidly encroaching on the grass area, as seen by the numerous clumps of young willows noticeable far towards the center of the marsh. On the outside, the shrubs are encircled by an equally irregular and interrupted belt of tamarack forest, varying in width from a few rods to a quarter of a mile. Outside of this the ground rises rapidly to the usual rolling uplands of the region. These are clothed with oak forest, which in many places is on the point of transition to oak-and-maple woods; with the basswood conspicuously numerous. (1)

In a few places the outer belt of tamarack is absent, and the salicetum approaches nearly to the foot of the slope. Here there is between the hardwood forest and the willow brush a narrow belt of mesophytic grassland, on which both forest and brush are encroaching. The outposts of the forest are especially *Populus tremuloides*, while in these drier portions of the salicetum *Salix nigra* and *S. amygdaloides* are more conspicuous than the species mentioned above. There is another characteristic difference in the aspect of the salicetum, according to the degree of wetness. In the lower places the willows show greater lateral than height growth, so that where a clump stands alone in the surrounding grass marsh, it assumes a circular form, like a bowl turned over, with the diameter of its ground area greater than the greatest height, which is in the center. On comparatively dry ground, the height growth is more vigorous than the lateral spread; the individual shoots are fewer in number, and they show much greater diameter. *S. nigra* and *amygdaloides*, in such places, often assume tree forms. (2)

1. Near by, a little south of Calhoun station, there is a twenty-acre timber lot which is as good a specimen of young maple wood as there is in the region. There are comparatively few old trees left, and these are about one-third oak and basswood, the rest sugar maple. The very dense underwood of large saplings is composed entirely of maple, except for an admixture of hop hornbeam. Oak saplings are entirely absent. The forest floor is formed by dry leaves, with very scanty herbage. This wood, however, is surrounded by a belt of oaks, greatly thinned, which forms a strange contrast. Here the grass occupies the ground to the exclusion of almost all other herbs. Clumps of hawthorn give the area almost the character of heath. There are no young trees, and the old oaks show signs of lessened vitality.

In the midst of this belt, by the way, stands a magnificent, broad-crowned specimen of *Acer nigra*, which is not a common species in this region.

2. Compare Bruncken, Distribution of Some Trees and Shrubs in the Vicinity of Milwaukee. Bull. Wis. Nat. Hist. Soc., Vol. I, page 38.

Coming now to the tamarack belt, a brief study convinces one that this association is doomed to disappear, even without the interference of man. All its neighbors are making vigorous inroads upon its area. The shrubs from the salicetum are infringing on it, and have penetrated to its very heart. In some places, black ash, elm and other swamp-loving hardwood trees are encroaching. Even the sedges from the marsh are creeping in through every opening, especially along roads made through the swamp. On the other hand, reproduction of the tamarack is entirely wanting. There are no seedlings. The smallest trees are about three inches in diameter, and how old they may be can be guessed from the data given below.

This tamarack swamp, like all I have ever seen in Southeastern Wisconsin, is very different from those in the Northern districts. Instead of having a peaty soil, and a floor composed of sphagnum, the ground flora is not very different from that of the ordinary black ash or willow swamp. Sphagnum mosses are not entirely absent, but comparatively unimportant and confined to the wettest portions. The numerous *Ericaceae* and allied types, so conspicuous in the North, are absent. Only in the driest places, *Pyrola rotundifolia* var. *incarnata* is found, often in the company of *Majanthemum bifolium*, *Trientalis Americana*, and several mosses, especially of the genus *Polytrichum*.

During the past winter, some cutting had taken place in the swamp on the north side of the basin. The wood had been cut into billets and stacked, thus giving an opportunity to make some observations on the rate of growth of the tamarack. Twenty-one of the billets were measured and the annual rings counted with the following result:

1. Diameter, 6 inches; number of rings, 37.
2. Diameter, 6 inches; number of rings, 43.
3. Diameter, 5 inches; number of rings, 43.
4. Diameter, 6 inches; number of rings, 44.
5. Diameter, 5 inches; number of rings, 50.
6. Diameter, 7 inches; number of rings, 71.
7. Diameter, 7 inches; number of rings, 73.
8. Diameter, 5 inches; number of rings, 39.
9. Diameter, 4 inches; number of rings, 36.
10. Diameter, 6 inches; number of rings, 41.
11. Diameter, 4 inches; number of rings, 31.
12. Diameter, 6 inches; number of rings, 23.
13. Diameter, 10 inches; number of rings, 74.
14. Diameter, 3 inches; number of rings, 25.
15. Diameter, 6 inches; number of rings, 27.
16. Diameter, 5 inches; number of rings, 46.

17. Diameter, 4 inches; number of rings, 46.
18. Diameter, 11 inches; number of rings, 66.
19. Diameter, 10 inches; number of rings, 72.
20. Diameter, 5 inches; number of rings, 54.
21. Diameter, 4 inches; number of rings, 53.

The billets had no indication of their position in the living tree, so that no inference can be drawn from the number of rings to the age of the tree, except that even a three-inch stem is more than 25 years old. But the table shows clearly the extreme irregularity of the diameter increase as between different trees, and also the very slow growth. All the billets measured, as well as many others merely inspected, showed by far the widest rings toward the center, while the outward rings were invariably exceedingly narrow, showing that during the last twenty years, at least, diameter growth had almost ceased. In cases 1, 5 and 8 there were two rings, about half way between pith and bark, which were nearly twice as wide as those at either side, each being about one and a half millimeter in width. The height of tamarack trees in this swamp is as irregular as their diameter; the tallest may measure fifty feet. It is apparent from the old stumps left, that much larger trees formerly grew in this swamp; for some of these stumps measure fifteen inches, while at present trees of ten or eleven inches are rare, and most of them are much smaller. There is good reason to believe that the above conditions are typical of nearly all the tamarack swamps in the southern part of the state.

From above facts it appears that the small farmers who own these lands are very wise in cutting down tamarack tracts, as they are doing almost everywhere in this region. These lands are not peaty, but have a rich, although sour humus. If drained, they furnish arable land of excellent quality, and even without drainage the crop of marsh hay, which can be reaped from them annually, after the forest is cut, will be more valuable than anything the tamarack could produce under the prevailing circumstances. To the lover of wild flowers, to be sure, the rapid disappearance of the swamps is a source of regret, for among their tangled roots grow not a few species of orchids and other beautiful blossoms.

8. Some Plants from Sheboygan.

Mr. Charles Goessl, of Sheboygan, contributes the following list of plants collected by him in the neighborhood of that city during the year 1901:

Clematis Virginiana.

Anemone cylindrica. Along Black River.

Anemone Pennsylvanica.

Anemone nemorosa.
Hepatica acutiloba.
Hepatica triloba. Pine woods west of city. Not common.
Anemonella thalictroides.
Thalictrum dioicum.
Thalictrum polygamum.
Dentaria diphylla.
Cardamine rhomboidea.
Cardamine hirsuta.
Arabis lyrata.
Barbarea vulgaris.
Erysimum cheiranthoides.
Cakile Americana.
Thlaspi arvense.
Menispermum Canadense.
Berberis vulgaris.
Sanguinaria Canadensis.
Dicentra cucullaria.
Dicentra canadensis. Sparse.
Corydalis aurea. Sandy pine woods.
Ranunculus multifidus.
Ranunculus abortivus.
Ranunculus sceleratus.
Ranunculus fascicularis.
Ranunculus Pennsylvanicus.
Ranunculus acris.
Caltha palustris.
Coptis trifolia.
Aquilegia Canadensis.
Cimicifuga racemosa.
Actaea rubra.
Actaea alba.
Viola blanda.
Viola pubescens.
Viola palmata.
Lychnis Githago (Adv.).
Stellaria media.
Portulaca oleracea.
Claytonia virginiana.
Hypericum Ascyron.
Elodes campanulata. Town Rhine.
Geranium maculatum.
Oxalis stricta.
Impatiens fulva.
Celastrus scandens.

Rhamnus cathartica.
Aralia racemosa.
Aralia hispida. Scarce along Black River.
Aralia nudicaulis.
Aralia trifolia.
Saxifraga Pennsylvanica.
Mitella diphylla.
Heuchera Americana.
Penthorum sedoides.
Hamamelis Virginiana.
Epilobium angustifolium.
Oenothera biennis.
Circaea Lutetiana.
Circaea alpina.
Echinocystis lobata.
Polygala paucifolia.
Polygala Senega.
Polygala polygama.
Melilotus officinalis.
Melilotus alba.
Vicia cracca.
Lathyrus ochroleucus.
Apios tuberosa.
Amphicarpaea monoeca.
Prunus pumila.
Prunus Pennsylvanica.
Prunus Virginiana.
Prunus serotina.
Spiraea salicifolia.
Physocarpus opulifolia.
Geum album.
Geum Virginianum.
Potentilla Norvegica.
Potentilla palustris.
Potentilla Anserina.
Potentilla Canadensis.
Agrimonia Eupatoria.
Rosa Carolina.
Rosa humilis.
Amelanchier Canadensis.

Preliminary Notice of the Forests Beds of the Lower Fox.

PUBLIUS V. LAWSON.

The forest beds of the Lower Fox River have been little exploited. They are found in parts of four counties, underlying an area of 500 square miles between the modified glacial till and Champlain clays.

The pre-glacial valley occupied about the same limits as the present one, extending from the Niagara limestone bluffs on the eastern border, to the Trenton outcrop on the western, and being about fifteen miles wide. But the pre-glacial river bed lay to the east of its present location and over against the foot of the Niagara limestone range. The glacial till filled the valley, as well as the present site of Lake Winnebago, to a depth of about 75 feet.

After the glaciers had receded, the waters of the river filled the whole valley. For many years these waters cleared away the clay from its bed and scouring the limestone rocks deposited its cements here and there in a hardpan, almost impossible to disturb with a pick. This has been stated to be the Beach Formation "A" of the Wisconsin Geological Survey, but it seems to have been a river bed product, rather than a lake beach formation. Above this river bed grew this ancient forest, which now lies buried under from ten to one hundred feet of the lacustrine modified red clay of the Champlain Sea.

Above the polished gravel and hard pan of the river bed grew the forest, forming a bed which is even now, after ages of pressure under millions of tons of later deposits, one and two and in places even three feet in depth. This bed is composed of moss, leaves, grasses, seeds, limbs and branches of trees and saplings and the trunks of trees of all sizes up to 24 inches in diameter. The moss and leaves are pressed into a compact mass, of a dark brown color, bearing patches of light-green or white mould. At John Roy's farm in the Town of Harrison, Calumet County, there are said to have been taken out pine cones and pine logs. Along the border of Lake Little Butte des Morts we have taken out what seemed to be fragments of cedar, black ash and black oak trees, and stumps of trees of black ash and tamarack. At Forest Junction in Calumet County were taken at 26 feet in depth cuts of linden trees. The growth of this lost forest is characteristic in some places of lowland and in others of highland localities.

That the remains of forest growth are not flood wood is evidenced by the stumps still standing with their roots in the soil where they grew. All these stumps bear evidence in their ragged heads of the trees having been violently wrenched off. The most notable stump field is that at Lewis Hankey's brick yard in the Town of Neenah on the west shore of Lake Little Butte des Morts. Here the removal of twelve feet of red clay in brick making has uncovered several acres of stumps still standing and about twelve inches high. The bed of vegetable mould and leaves is here several inches thick and rests on a thin layer of blue clay over the river bottom formation. In 1897 we published an article in the Oshkosh Northwestern on this forest bed in which we described a stump eighteen inches in diameter, fourteen inches high, discovered on Augustine's farm, one mile east of Menasha, under 26 feet of red clay, which had been artificially severed. The forest is found in well diggings along the borders of the slough which enters the south end of Lake Little Butte des Morts. It extends six miles along the western border of the lake at the about the level of the water and is found at Allison's place and Alward's Foundry at a depth of twenty-six feet in well diggings. At one place a log twenty-four inches in diameter was penetrated. But for three miles along the eastern shore of Little Lake Butte des Morts there are exceptional opportunities to study the bed, as at low water it is exposed just above the level of the water, and the ragged stumps rising up through the red clay beach are used by the fishermen to fasten their boats, and wagon loads of its ancient woods can be obtained in a few hours. Along the lands bordering this shore it is found in digging wells at depths varying from six to nineteen feet. At the Pulley Factory in Menasha at sixteen feet, the bed contains a mass of trees from four to twelve inches in diameter, mostly cedar and pine, with two feet of the brown moss and leaf mould. At Round's farm three miles down the lake it is found at sixteen feet; at Tyckman's half-way house, one mile east, at seventy feet. It was traced in Manasha for a distance of over a thousand feet at a depth of thirteen feet when Sixth Street sewer was laid. Two miles further east it was found at Bayer's farm at thirty feet. Near Hunt's farm it was found at two places at ten feet. Further east of Menasha, in the Town of Harrison, north of Lake Winnebago, it was found at Geo. Schwalbach's place at sixty feet in depth. At Mix's place, three miles east, large trees were drilled at eighty feet. At Loux's place it was penetrated at forty feet; at John Roy's place at nineteen feet; at the base of the Niagara bluffs at Clifton on Nugent's place at fifteen feet; near Sherwood in Calumet County at eight feet on top of blue clay; at Forest Junction

at twenty-six feet on blue clay of the Cincinnati shale. Several of the above levels of the forest bed are from forty to fifty feet below the level of Lake Winnebago. Coming now back west to Appleton in Outagamie County it is found on the south side of the river at one place at a depth of twelve feet on blue clay. At Appleton in the Fourth ward on the south side of the river at a well drilled for Father Kaster's Church or Hospital, the reading of the soil, made by Geo. Schwalbach, driller, was as follows: Red clay, 60 feet; hard logs, 2 feet; blue clay, 1 foot; soft logs, 2 feet; gravel.

We now come to the region north of Appleton which we might name the "Gas fields of Outagamie County." I am informed by Mr. Picklin, well driller, that no forest bed is discovered in the town of Cicero; but between this town and Appleton it is found in the towns of Black Creek, Center and Grand Chute. I have one reading of a well made in Center by Mr. Picklin: Red clay, 15 feet; sand, 80 feet; blue clay, 25 feet; wood, leaves and stumps, two feet; gravel. At Linas' farm, north of Appleton, he found logs twelve to fourteen inches diameter at forty-five feet in depth. Mr. Joe Pringle, well driller of Binghamton, sends me reading of the recent gas well, so widely heralded in the public press: Clay, 7 feet; sand, 15 feet; red clay, 40 feet; gravel, 12 feet; red clay, 6 feet; trees, stumps, leaves, 2 feet; gravel, 10 feet; rock.

This well was located nine miles east of Wolf river, in the town of Center, about seven miles north of Appleton. A number of wells in the surrounding country have been noticed to give off gas. A similar gas well was discovered several years ago in Grand Chute and created considerable flurry in speculative circles. This was marsh gas produced by decaying vegetation of the forest bed. The moss, leaves and wood from the forest bed are only partially rotted. The wood after being dried becomes hard and brittle. Some fragments supposed to be oak have turned partly into lignite. This snaps into fragments on slight pressure and is black and glassy on fracture, bearing the appearance of coal.

At Green Bay some trace of this submerged forest is reported to us by drillers at twenty-four and fifty feet below the surface; and Prof. Chas. Whittlesey in Foster's and Whitney's Report on the Lake Superior Land District, published in 1851, part 2, page 394, reports in a boring at Green Bay, at a depth of forty-three feet, a bed two feet thick, of rotten wood and leaves lying between strata of red and blue clay. The wood being submitted to M. Lesquereux for examination was pronounced by him to be cedar.

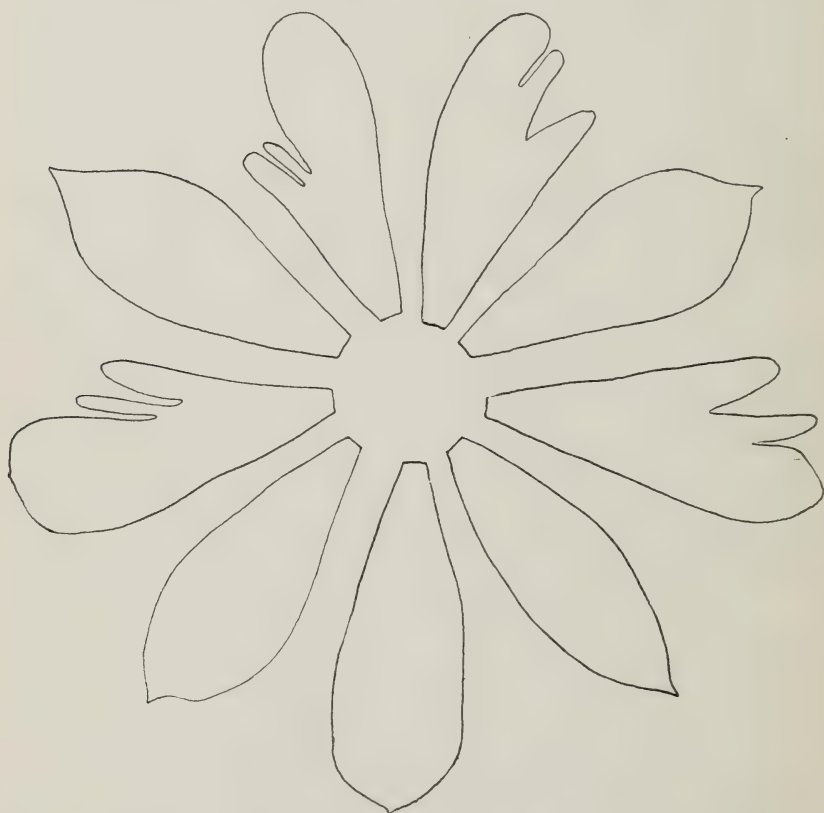
The vegetable remains of this ancient forest have never been subjected to expert investigation and the names above given may

not be the correct ones. The bed has never been explored by geologists, and much yet remains to be done in the way of determining its extent in the state and the conditions under which it was formed. The forest seems to have extended considerably beyond the region above described, as particles of buried wood have been brought up by well-diggers from great depths, and escaping gas detected at various localities near the eastern boundary of the state as far south as the southern portion of Milwaukee County.

Note on a Bilateral Tulip.

ROSWELL HILL JOHNSON.

The tulip here referred to was observed in the greenhouses of the Howard Botanical Garden in the early spring of '99. Since I find that only one other case of this kind is on record I venture



to send you this drawing of the perianth-segments, the only record I made at the time. Although the four lobed segments are not identical, the nature and position of the lobes show apparently a fundamental bilaterality.

The previous case is that described by A. Pippow in "Ueber das Auftreten scheinbarer Zygomorphie bei regelmaessigen Bluethen," in "Sitzungsberichte d. Bot. Ver. d. Prov. Brandenburg 1877, p. 74." I have been unable to see the original article. It is referred to in Penzig's "Pflanzen-Teratologie" as follows: "Durch symmetrisch vertheilte Einschnitte in den Perianthblaettern werden die Bluethen gelegentlich pseudo-zygomorph."—University of Wisconsin, March 1, 1902.



BULLETIN
OF THE
WISCONSIN
NATURAL HISTORY
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THE MIGRATION OF BIRDS, WITH SPECIAL REFERENCE TO NOCTURNAL FLIGHT—H. A. WINKENWERDER.

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The Migration of Birds

With Special Reference to Nocturnal Flight.

H. A. WINKENWERDER.

PREFATORY NOTE.

During the fall of 1897 Dr. O. G. Libby called my attention to the excellent facilities the telescope offers for the study of bird migration, and upon his advice I took up the following work in the summer of 1899. It was intended that the paper should be complete in 1901, but owing to the pressure of other work and the amount of material collected this became impossible.

Since so much in any one phase of the subject of migration depends upon a knowledge of the phenomena of the other phases, it becomes necessary to treat certain parts of the entire subject in order that the reader may obtain a clear understanding. The following paper is consequently divided into four chapters, A Historical Review, The Causes of Migration, Migratory Routes, and The Manner of Migration.

The reasons for presenting a historical review are (1) because I had the material on hand; (2) because the only paper of this nature in the English language, that of Dr. J. A. Palmen in the Smithsonian Report of 1892, deals only with the development of certain phases of the subject, and tells very little of the work done in America; (3) because it is an important adjunct to the rest of the paper. For much in this chapter I am indebted to Palmen's Ueber die Zugstrassen der Vögel.

I am aware that for the past decade, or a little more, there has been a tendency to attribute the causes of migration to the failure of food. It is still, however, a very general belief, especially with regard to the spring migration, that food is only a minor cause. Furthermore, I am not aware that the causes of migration have ever received special treatment, hence have included a chapter on this subject.

The remaining two chapters are the result of a method of investigation that has heretofore received very little application. The telescope offers a means for watching nocturnal migrants while they are in actual migratory motion. Though we gain a view of only an infinitesimal portion of the vast migratory wave in so small a field of vision, enough is revealed to make it well worth the undertaking.

Since a great deal of the work on migration has been done in Europe, I have been unable to secure much of the valuable literature that I should have had. For such as I had access to I am indebted to Mr. H. Nehrling and Mr. Paul Dernehl, both formerly of the Milwaukee Public Museum.

I wish especially to express my thanks to Dr. O. G. Libby for the abundant help he has given me and the interest he has shown throughout the entire work. Also to Prof. Geo. C. Comstock, of the Washburn Observatory, for the use of telescopes. One of three instruments—the finder on the large telescope, the students' telescope, or a large portable telescope—was at my continual disposal. Other acknowledgments will be found in their respective places.

CHAPTER I.

HISTORICAL REVIEW.

No one can doubt that the great semi-annual movement of the migratory birds must have been noticed and commented upon even from the earliest times. The Prophet Jeremiah refers to the appointed times of the stork. Anacreon wrote in his Thirtieth Ode,

"Lovely swallow once a year,
Pleased, you pay your visit here;
When our clime the sunbeams gild
Here your airy nest you build;
And when bright days cease to smile
Fly to Memphis or the Nile."

So far back as the times of Hesiod, we are informed that husbandry was in great part regulated by the coming of the birds. It has been stated that Persians and Arabs compiled portions of

their calendars according to the regular movements of the birds; that North American Indians foretold an early spring or a cold winter by the appearance or disappearance of birds; and that superstitious people of all times saw forebodings of good or ill in certain of the migratory movements.

But it can be said that prior to the eighteenth century bird migration was scarcely looked upon as a biological phenomenon. Dixon says that Belon watched birds migrating three hundred years ago, that a century and a half ago Gilbert White (1), Denis Barrington and Thomas Pennant watched migratory movements in England, and on the continent contemporaries with Linnæus studied these periodical flights (2). Palmen says: "Linné admonished natural philosophers to observe the migration of birds. Quetletet then in the year 1841 asked that changes in living nature also be noted in a regular and comprehensive manner, and his countryman de Selys Long-Champs proposed to collect data especially on the migration of birds" (3).

But it was not until the middle of the nineteenth century that this study began to assume a systematic form. The collection of data on migration, however, was at first of secondary importance, the material being used for climatological purposes. Although a few individual observers were occupied in watching these movements for over two hundred years before this, nothing could come of such few and incomplete observations. Each observer formed his own conclusions, resulting in such absurd statements as that migratory birds went to the moon, that certain species were transformed into others, and some of the world's most eminent naturalists held the idea that birds became torpid and passed into a state of hibernation. This last theory held a prominent place for a long time, and relative to certain birds even to very recent times (4).

From 1840 to 1876 much work was done on zoography, but much of the material collected was used by climatologists with a view to finding an expression of the corresponding regions. Although Dernham as early as the year 1708 published a work on the periodicity of migration and its relation to climate, similar work was not undertaken until in the time of Quetletet in 1841, and then for climatological purposes. While it cannot be said that

1. Gilbert White, *Natural History of Selbourne*.

2. Dixon, *The Migration of Birds*. London, 1892, p. 123.

3. Palmen, *Report on the Migration of Birds*. Smithsonian Report. 1892. P. 375.

4. Cowes, *Birds of Colo. Valley*, pp. 372 et seq.

this climatological work was a lurking remnant of the superstition of the people when they first noticed the regular movements of certain birds, we may look to this as the probable origin of these lines of investigation. A writer in *All the Year Round* says: "When man began to meditate upon the movements of certain birds, how they all disappeared at a certain time as if by common consent, and then reappeared after a certain interval, they not unnaturally fell into the error of mistaking cause for effect and regarded the birds as regulating the seasons instead of the seasons the birds" (5).

Zoologists, however, saw another use for these data and it was mainly through the influence of two naturalists in Russia that this climatological material was turned to zoological ends. Kessler in 1852 attempted to determine something of the courses taken in migration, but arrived only at the general directions followed (6). Middendorf two years later called attention to the importance of working over the material collected by the climatologists, and during the same year made the first attempt to reduce the flight of birds to law (7).

Most of the work on migration was now directed toward an attempt to determine the direction of flight. Though many of the first fruits of this work were of little value from the standpoint of fact they immediately led to those important lines of investigation which were to form the foundation of research in migration.

Although systematic work was now in progress, the direction which the course of investigation must take was not clearly understood until 1871, when Sunderal made known the routes of the crane in Europe. It then became evident that there were definite routes followed in migration and that these routes would have to be the first phenomenon to be dealt with. That definite routes were followed had already been hinted at by Linne, Schlegel, L. Brehm, J. F. Nauman and Baird, but it remained for Palmen to give definite form to this line of investigation. Brehm as early as 1828 refers to "Heerstrassen," and in 1846 Nauman added to this the idea of definite resting places—"Erholungsorten"—stations at which birds stopped in their long journeys to rest and feed (8). Middendorf in 1859, from careful investigation, showed almost conclusively that the migratory movement takes

5. *All the Year Round*, vol. 13, p. 376.

6. Palmen, Ueber die Zugstrassen der Vögel, pp. 11 and 12.

7. *Ibid.*

8. Palmen, Ueber die Zugstrassen der Vögel. Leipzig, 1876, p. 6.

place in a general north and south direction in eastern Europe (9). Although he fell into serious error regarding migratory routes, his methods of investigation were good and acted as a stimulus to other ornithologists throughout Europe and western Asia. Another important advance was made in 1866 by Dr. Baird when he traced the lines of dispersion of a number of American birds and intimated very strongly that birds followed certain geographical features in their migrations (10). Baird's work is of great importance. He certainly anticipated the work of Palmen. It is indeed peculiar that a work of such importance did not immediately stimulate others to direct their efforts along these lines.

Palmen saw the necessity of pursuing a definite course of investigation and followed these initial movements by studying in detail the routes of a small number of hyperborean species. In 1876 he published his results under the title, "Ueber die Zugstrassen der Vögel" (11). Beside having thus laid the foundation for the study of most migration phenomena he immediately reaped some of the results that were to follow. He not only showed that definite routes were followed, but established definite fly-lines for entire Europe. Through these investigations we may also say he fixed our present laws regarding migratory routes, namely, that these routes are geographically defined courses.

These principles of Palmen were at first rejected from nearly all sides. His statements were not only looked upon as conjectural but even rash. However, as investigation proceeded, the importance of his work gradually became more and more evident and it was quite soon accepted (12).

With the increasing interest in migration among zoologists the time was ripe for theory. Prior to the work of Palmen the theoretical side of the question was largely speculative. One theory which had some influence in the scientific world was that of the Swedish poet Runeberg who claimed that migration was caused by the season of perpetual darkness in the north. He conceived the idea that as darkness gradually fell over the north pole the birds were attracted southward where there was more light. Another interesting case is that quoted by Prof. Newton from the London Times for September 18, 1874, which professes to give the latest accepted theory:

9. Die Isopiptesen Russlands. Mem. Imp. Acad. of Sciences of St. Petersburg, 1859.

10. Baird. Amer. Jour. of Science, 1866.

11. Palmen, Ueber die Zugstrassen der Voegel. Leipzig, 1876.

12. Nature, vol. 15, p. 465; vol. 11, p. 433. Journal f. Ornith., 1876, p. 390.

"I believe it was only some twenty or thirty years ago that anything like a practical solution of the difficulty was arrived at. The birds congregating about the south coast (i. e. of England) are seized with a sudden impulse, or mania, to fly upwards. This is caused by some atmospheric change, coinciding with a warm south wind moving in a high stratum, into which the birds soar with an involuntary motion of the wings. This motion (involuntary like that of the heart) is continued for many hours, and the birds fly blindly along until the paroxysm passes off, when they at once begin to descend, making many a fatal drop into the sea" (13).

The results of Palmen's work, however, threw light upon the causal phenomena of migration, and we have the appearance at about this time of two excellent theories explaining the origin and causes of migration. Although various influences connected with this phase of the work had been correctly hinted at by Darwin, Baird (14), Newton (15), Hutton, and others, it was not until 1874 when Dr. Alfred R. Wallace advanced an explanation that we have had a really excellent theory in complete and concise form. This was about the time when Palmen's work appeared; whether Wallace was influenced by the work of the latter or not is difficult to say. If not he certainly anticipated something of the nature of his results. Another theory appeared soon after from the pen of Dr. August Weismann, who tells us that he fully accepts the results derived by Palmen.

Wallace writes, "It appears to be probable, that here, as in so many other cases, survival of the fittest will be found to have had a powerful influence. Let us suppose that in any species of migratory birds breeding can, as a rule, be only safely accomplished in a given area; and further, that during a great part of the rest of the year sufficient food cannot be obtained in that area. It will follow that those birds which do not leave their breeding area at the proper season will suffer and ultimately become extinct; which will also be the fate of those which do not leave the feeding area at the proper time. Now, if we suppose that the two areas were (for some remote ancestor of the existing species) coincident, but by geographical and climatic changes gradually diverged from each other, we can easily understand how the habit of incipient and partial migrations at the proper seasons would at last become hereditary and so fixed as to be what is called an

13. *Nature*, vol. 10, p. 415.

14. *Am. Jour. Science*, 1866; p. 178 et seq.

15. *Nature*, vol. 10, p. 415.

instinct. It will probably be found, that every gradation still exists in various parts of the world, from a complete coincidence to a complete separation of the breeding and subsistence areas, and when the natural history of a sufficient number of species is thoroughly worked out, we may find every link between species which never leave a restricted area in which they breed, and live there the whole year round, and those other cases in which the two areas are absolutely separated" (16).

This theory exerted much influence upon the students of the time and is still often quoted as an explanation.

Weismann presented his theory in a quite lengthy discussion in 1878 (17). His first step is to show why birds migrate at all, and he arrives at the conclusion that it is mainly due to an absence of food in the northern and southern portions of the geographical distribution of birds at opposite seasons of the year. He conceives the idea that the original home of the birds is in the tropics, and that from here they dispersed into the temperate and frigid zones, met with unfavorable conditions in winter and were forced to seek new areas. A struggle for existence ensued, resulting in the survival of those that returned to the south. Through natural selection the phenomenon of migration then became an instinct.

"Let us suppose, for example," he says, "that the waxwing had not become an inhabitant of Russia, but was living summer and winter alike in Germany, slowly multiplying and therefore gradually extending its range further north.

"Now we will imagine a flock of these birds to have colonized further north. In the very first winter they would find their food becoming scarce, and would be compelled to wander about in search for it; all, that is to say, which had taken a wrong direction. Only those which, whether by accident or by remembering the way they had come, took a southerly course, would have any prospect of outliving the winter.

"In each succeeding winter, therefore, a selection would take place among the northern colonists, and only those would remain alive which had migrated southward. As these alone would remain to perpetuate in the next year, this habit of a southerly flight would be transmitted to their descendants, and so a race would arise predisposed by habit not to wander hither and thither

16. *Nature*, vol. 10, p. 459.

17. *Contemp. Review*, vol. 34, p. 531.

in winter, like the green woodpecker (18), but to take a definite direction, namely, to the south."

He then shows that in the eider duck of Europe we have every stage from a migratory bird to one that is stationary, and we find it, therefore, in the Arctic zone a genuine migratory bird, in the Baltic only a wanderer, and in the North Sea a resident—"a conclusive proof that migration and wandering are not essential characteristics of the species, but a habit which is adopted when the necessities of life require it, and a proof, moreover, that the regular migration has grown out of the irregular wandering in search of food."

Much valuable work as well as much speculation has also been done on the question how birds find their way between their summer and winter homes. The first careful investigations on this subject were undertaken by Dr. A. von Middendorf, in 1855, and resulted in his well known work *Die Isopiptesen Russlands* (19). He found that the direction of migration in Russia is in general toward the north pole, and conceived the idea that birds must be endowed with a sixth sense, a magnetic sense of direction. Palmen, a few years later, revealed Middendorf's error when he showed that the direction followed depends almost entirely upon the topography of the countries through which the migrations extend (20). The general belief then was that young birds are first led over a course by one or several older, experienced birds, and that through sight and memory these courses are followed year after year. The investigations of the older American ornithologists seem to indicate that this is actually the case (21). Herr Gatke, however, seems to find from his extended observations on Heligoland that it is not so there. He says innumerable flocks pass his station of observation year after year composed entirely of young birds (22). This subject has been the cause of much controversy among ornithologists and is still an unsettled question. Recent observations along this line show us nothing definitely one way or the other (23).

18. Or like our waxwing, the tree sparrow, many of our hawks, and others.

19. *Die Isopiptesen Russlands*. Mem. of the Imp. Acad. of Sc. of St. Petersburg, 1859.

20. Palmen, Ueber die Zugstrassen der Voegel.

21. Brewster, Bull. Nutt. Ornith. Club, No. 1, p. 15.

22. Heligoland, An Ornith. Essay, 1895.

23. Barrington, The Migration of Birds observed at Irish light-houses, 1888-'97. Dublin, 1901; also Bailey, Proc. Del. Valley Ornith. Club, No. 3, p. 13.

Before 1850 comparatively little was accomplished. At about this time the subject of migration seems to have become of interest to zoologists in general. In America the initiative was taken by Dr. Baird in 1866 (24). In Europe, although the work was well under way, interest increased immensely. The investigations of Herr Gatke, Middendorf, Severtsoff, Homeyer, and Palmen, now appeared and stimulated others to action. May the 22nd, 1875, the General German Ornithological Society met at Brunswick and undertook a systematic collecting of data. This marks the beginning of a national form of investigation. The ornithologists of a nation combined their efforts and elected officers who could supervise the work to the best advantage. Similar work was begun in England in 1879, and in Austria-Hungary in 1880, while the remaining countries of northern Europe followed their example during the next few years (25).

In our own country similar investigations were begun by Prof. Cooke in 1881. Prof. Cooke's field of observation included that part of North America ordinarily known as the Mississippi Valley. All the ornithologists of the district were asked to co-operate in the collection of data. Although observations were contributed from only thirteen persons in 1881, another attempt was made in 1883 resulting in reports from twenty-six persons. The results of these investigations were published in the leading ornithological periodicals of the time.

In 1883, the year which marks the advent of the American Ornithologists' Union, the work begun by Prof. Cooke was widened into a scheme of national extent. A committee, with Dr. C. Hart Merriam as chairman, was appointed to co-operate with Prof. Cooke. This gave a great stimulus to ornithologists all over the country, and the list of observers, now nearly 700 strong, was scattered all over the United States, British America and Alaska. Beside this the committee secured the co-operation of the Light-house board. The field of observation was divided into fourteen districts each with a competent superintendent at its head. With such an elaborate and extended scheme it is not to be wondered at that the results have far exceeded all expectations (26).

24. Baird, *The Distribution and Migration of N. A. Birds*. Amer. Jour. of Science, 1866; pp. 78 et seq.

25. Palmen, *Rep. on the Migration of Birds*. Smith. Rep. 1892, p. 3. For accounts of the work done by these societies see Jour. Ornith., 1875-1883.

26. Merriam, *Auk*, vol. 2.

The work of Cooke, superintendent of the Mississippi Valley District, has broadened into several new fields of inquiry. In addition to the report proper he has included original discussions upon "The Relation of Migration to Barometric Pressure and Temperature" and "The Rate of Speed at which Birds Migrate." Although these new phases of the work were not undertaken until the period of investigation was nearly completed, and hence were merely experimental, the methods employed have opened several new fields to the students of migration (27). Mr. Witmer Stone followed Prof. Cooke's method of work on a less extended basis and has presented us with a means of representing "bird waves" (28), graphically (29).

Another entirely new department was brought into the method of observation in 1880, by Mr. W. E. D. Scott, who applied the telescope to the study of migration problems. This method, although of extreme importance, seems to have found little actual application. Beside the work of Messrs. Allen and Scott in 1881, and that of Mr. Frank Chapman in 1887, practically nothing was done until it was taken up by Dr. O. G. Libby of the University of Wisconsin in 1897. Since 1898 the telescope has been used for this purpose by Dr. Libby and the writer, at Madison, Wisconsin, each year up to the present time. During the spring of 1900 a wider application of this method was obtained by asking a number of interested persons from our western universities to co-operate. These data together with all those that were taken at Madison will appear in the following report.

The facilities for studying migration at light-houses have long been known. It was upon the suggestion of Prof. Newton in 1880 that a systematic collecting of data from this source was first undertaken. Individual work at light-houses by experienced ornithologists has given us many valuable facts. Indeed the investigations of Herr Gatke on the Island of Heligoland (30), of Brewster at Point Lepreaux (31), and Chapman on Bartholdi Statue (32), should stimulate others to direct their efforts along these lines.

27. Cooke, Rep. on Bird Migration in the Miss. Valley. Bull. No. 2, U. S. Dept. of Agr. 1888.

28. A "*bird wave*" may be considered to consist of a very large number of individuals, of one or more species, which suddenly invade a certain area."—(Cooke.)

29. Auk, vol. 8, p. 194.

30. Heligoland, An Ornithological Essay. 1895.

31. Bull. Nutt. Ornith. Club, No. 1, 1886.

32. P. S. M., vol. 45, p. 506.

During the past fifteen or twenty years much valuable work has been done on geographical distribution. Every student of migration must recognize the importance of a knowledge of the geographical distribution and dispersion of birds. The extended works of Baird, Allen, Merriam, Chapman, Hasbrouck and others on distribution, and the local bird lists that have appeared in recent years are invaluable as aids in the study of migration problems. During the past twenty years a great advance has been made in work of this nature. Beside the many town and county lists that have appeared, there are state lists for many of the states of eastern North America. From the Bahamas, the West Indies and the northern portions of South America much information has been obtained on the distribution of birds that is invaluable for the study of migration problems.

Thus the problems of migration, after passing the period of superstitious beliefs, were next pursued for their immediate importance to climatological ends. At about the middle of the nineteenth century naturalists turned them to the interests of zoology. The first point, then, was to establish the most advantageous course of study, which resulted in the national form of investigation. During the past two decades, besides the many important results obtained, new fields and methods of investigation have been opened to the student, and at the present time individual observers and others united into societies are at work in nearly all parts of the world.

CHAPTER II.

THE CAUSES OF MIGRATION.

We know that birds leave us in the fall and that they return again in the spring; we know something of their habits during migration, and we know of the changes in living nature concomitant with many of these flights. There are, however, so many influences that might affect migratory movements that this subject is not easily handled. Whatever these influences are, we know that they affect different birds in different ways; that they are operative over vast areas at the same time, and set countless numbers of birds in motion simultaneously. In the fall migrations begin with the sunny days of July and continue even until the earth is covered with snow and ice. In the spring some of our migrants may be seen as early as the middle of February, while others are still on their northward way when the first have already performed their parental duties. So closely do spring and fall movements approach each other that only a narrow interval

of time, if any, separates them. Thus we have a multitude of diverse conditions: changes in temperature, humidity and living nature, any or all of which may have an influence upon migratory birds.

In the yearly cycle of migration we have the northward movement in the spring and the southward movement in fall. With a very few exceptions, writers upon this subject seem to have been agreed that there are different influences operating in each instance. In the fall it was the approach of winter and the failure of food, in the spring the love of home and nesting ground, and the difficulties of breeding in the south. There can be no doubt that of these various influences each may play some small part as a factor in the causes of migration. Let us analyze the various influences.

From a merely superficial view of the physical conditions existing during the migratory season it would seem that temperature is a most important factor as a cause for the fall migration. Indeed, it was considered so for a long time, but at present it is beginning to be looked upon as only of secondary importance. Almost every student of birds can cite cases where strictly migratory species have wintered far to the north of their northern winter limits, when the food supply was sufficiently abundant to insure their existence.

Prof. Cooke says: "Thus many Red-headed Woodpeckers remain through the winter in northeastern New York, frequenting the heavy timber where there is a great quantity of their favorite food; and it is not unusual for a few Robins to spend the winter in north central Wisconsin, sheltered by the thick pine forests; while ducks and even Wilson's snipe have been known to remain throughout the whole winter in Wyoming, near the hot springs, whose warmth kept the neighboring waters and ground from freezing" (33).

Dr. O. G. Libby has noted a Wilson's Snipe remaining near an open spring in northern Wisconsin the whole winter. Instances of this kind are met with almost yearly. During the winter of 1899-1900 a remarkable case was brought before the writer. In November, 1899, the Red-headed Woodpecker was observed storing acorns in the crevices of the bark of our larger oaks (see frontispiece). Before winter had fairly set in a great many trees about Madison contained hundreds of the acorns. As the winter

33. Cooke. Rep. on Migration in Miss. Valley. Bull. U. S. Dept. of Agr. Div. Econ. Ornith., No. 2, p. 11.

wore on they gradually disappeared, and upon the approach of spring they were nearly all gone, having been eaten by the birds. Upon further investigation these birds were found distributed in certain localities throughout the state as far north as Polk County, in some instances in groups of over a hundred. In the majority of cases the acorns were found with the birds (34).

These cases show rather strikingly that the influence of temperature upon migratory birds cannot be universal. The frequency, however, with which like phenomena have occurred, and the wide range of species that have been observed under similar conditions, might lead us to believe that temperature, *per se*, has no influence whatever. In fact, when we consider that many of our warblers, fly catchers, vireos, and others, leave for the south at times when they might still enjoy from one to two months of mild weather before the approach of winter, it would seem that even among the more delicate species temperature has a less determined influence than is generally supposed.

In the examples given above we have in each instance found that the locality in which these species were discovered was connected with some unusual source of food supply. The term unusual should be emphasized because the phenomenon we are discussing is an unusual phenomenon and we may expect an unusual cause. When two phenomena are thus uniformly associated we may be justified in making one the cause of the other. The importance of food as a factor in migration at once becomes evident. According to their food habits birds may be classified as animal-feeders and vegetable-feeders, according as they show a preference for animal or vegetable food. From a migratory point of view they are classified as summer residents and winter residents, the former including those that migrate south at the approach of winter and the latter those that remain in the north throughout the year. Thus, as winter residents we have the ruffed grouse, the crossbills, the pine grosbeak and the linnets as examples of vegetable-feeders; and the creepers, tits, nuthatches, hawks and owls as examples of animal-feeders. Among the summer residents are the thrushes, fly-catchers, cuckoos, snipes, plovers, warblers, vireos, swallows, the meadow lark and the bobolink as animal-feeders; and the red-winged blackbird, pigeons, ducks, geese and a few of the sparrows as vegetable-feeders. It is a noticeable fact that in winter examples of strictly vegetable-

34. Winkenwerder. Notes on the Winter Habits of the Red-headed Woodpecker. Bull. Wis. Nat. Hist. Soc., vol. 2, N. S., p. 69.

feeders are much more readily found than animal-feeders, which is not at all surprising, since the proper kind of animal food is very scarce during the winter.

We may classify the food of birds according to the following table:

1. Food accessible only in summer.

A. Animal food: most insects—adults, larvæ, eggs; myriopods, crustaceans, molluscs, worms, batrachians, reptiles, fishes.

B. Vegetable food: all soft fruits, flowers, leaves and all green vegetation.

2. Food accessible summer and winter.

A. Animal food: birds, mammals (in limited numbers), a very few spiders and insects.

B. Vegetable food: buds, seeds and nuts in abundance, a few berries.

An examination of this table will show that both the animal and vegetable foods accessible in winter will not be accessible except to such birds as are especially adapted to obtain them. Hawks and owls are adapted to feed upon birds and mammals, themselves winter residents; the chickadee, nuthatch and brown creeper—which we might call our winter insect-feeders—are adapted to feed upon such food as they obtain by prying about in the crevices of tree trunks, fences and stone piles, where insects and spiders are lodged in abundance; the crossbills, linnets, grosbeaks, grouse and quail are adapted to feed upon seeds and buds. None of the *strictly* summer residents are physically capable of capturing birds and mammals. Among the insect-feeders that are summer residents we have, roughly speaking, three classes: (1) Such as obtain most of their food upon the wing, as the swallows and flycatchers; (2) such as obtain it largely upon the ground, as the meadow lark, and (3) such as obtain it largely from among the boughs and leaves of trees, as the warblers and vireos. Of these we cannot say that any are adapted to obtain food with the methods employed by the winter insect-feeders. So, too, with the other animal-feeders, such as are represented by the snipe and plover—in winter time their food is covered by snow and ice. The vegetable food accessible in winter, chiefly buds and seeds, is again of such a nature that unless a bird be especially adapted to obtain it he cannot remain here over winter. He needs must be a bird with a strong bill and well developed muscles to operate this in order to obtain a subsistence from the buds and seeds that are at all abundant in winter.

It will be needless to go further into detail regarding this matter. A little reflection shows readily that all birds are dependent upon certain kinds of food, that they are especially fitted by nature to obtain this particular food, and in nearly all cases are physically incapable of obtaining any other, and hence that in order to insure their existence they must migrate when their particular kind of food fails. In winter the food of our summer residents fails. Their animal food is not found where they are wont to capture it and their vegetable food is scarcely to be found at all. The food of the robin lies below the snow, that of snipe and sandpiper is covered by ice, and that of swallow and nighthawk is not now on the wing. The cherry tree is bare to the rose-breasted grosbeak, and for the warbler or vireo there is not even a leaf where he may look for an insect.

It has been maintained for years that the question of food will never explain the vernal migrations, however well it serves that purpose in autumn. Our study of the phenomena pertaining to bird life, until recently, has been very limited in the south. In the north, however, these phenomena have been worked out in detail. It has been shown that the most important factor in the fall migration is the food supply. The assumption that the question of food will not explain the vernal migration has probably been due to our ignorance of the physical conditions of the south. According to Dr. Aug. Weismann, ponds, rivers and creeks become dry, insects disappear and even vegetation fails in many regions in the south in summer. Dr. C. H. Merriam has more recently discussed this question from the same standpoint. Mr. C. R. Ricker says: "During the dry season many forest trees shed their leaves and the grass and small shrubs wither, while the palms and the majority of other trees bear their fruit; * * * *" (35). Hence we are at present quite safe in saying that birds must migrate both in spring and fall because the food supply fails. In fact, the investigations carried on in the south during recent years seem to corroborate these views. The investigations of Mr. Ricker along this line are especially valuable and it is hoped that future investigation in the south will help establish the facts that are still in a state of doubt. Mr. Ricker says further: "The abundance or scarcity of a large number of species I found subject to daily fluctuation, dependent upon the presence of the army ant or some fruit suddenly ripening, there being scarcely two consecutive days when birds could be

35. Ricker. *The Auk*, 1890, p. 131.

found plentifully on the same feeding ground." (36). Do not cases of this kind give us rather striking evidence that the food supply of the south is limited?

We have thus two areas in the geographical distribution of birds that are deficient in food at opposite seasons of the year, and we can see readily enough the cause for migration both in the spring and in the fall.

It is still a quite general belief that love of home and nesting ground is among the important factors causing the spring migration. Ornithological literature contains innumerable references to cases where birds have returned year after year to the same locality or even the same tree or the same box. Prof. Newton, in discussing this question, cites a case of this kind. "A pair of Stone Curlews (*Oedicnemus crepitans*), affecting almost exclusively the most open country," he says, "were in the habit of resorting for many years to the same spot, though its character was entirely changed. It had been an extensive rabbit warren and was become the center of a large and flourishing plantation. It seems to me, therefore," he says further, "that among the causes of migration the desire of returning to old haunts must be included" (37).

But Prof. Newton forgets that any of a vast number of influences, which have no direct bearing on the phenomena of migration whatever, may be operating upon the birds to bring them back to this same spot. In fact, it would seem in the case he has cited that other forces have been in operation. Old haunts would be attractive only on account of their surroundings. If, as he says, these were entirely changed, then, of course, they could no longer be attractive in and of themselves. It is a general belief that the sense of memory is well developed in birds; but, if the object of their memory no longer exists, by what shall they recognize the place?

We have found in the preceding discussion that birds are quite dependent upon their food supply, and that they are willing to undergo the hardships of an unfavorable environment providing their means of existence be assured. Furthermore, we know that birds must leave their most favored haunts if the conditions become unsuited to their needs of feeding and breeding. In another connection it will be shown that birds are quite dependent upon certain definite courses in their migrations, and that even in the absence of home affection they might be led to the imme-

36. The Auk, 1890, p. 131.

37. Newton. Nature, vol. 10, p. 416.

diate vicinity of their old homes. There can be no doubt that birds are endowed with well-developed mental capacities, and that it is by virtue of these that they return to the same tree or the same box. But even here we must consider the fact that if any individual, or species, develops certain characteristic habits in feeding, breeding, or whatever they be, so long as they are advantageous it will endeavor to find conditions where these habits may be practiced. While we may thus find birds returning to their old homes year after year, and while memory, home affection and habit all contribute as explanations for this periodical return to the same place, we must not forget that these influences may be merely local. The facts pointed out above show that they are local, but there are no facts from which we can infer that they are more than local.

We know that migration takes place in a general north and south direction, that definite physiographic courses are used as guide-lines in migration, and that some birds return year after year to the same home. It has been shown that there are reasons why birds should leave the south in spring, and it will be shown that even in the absence of home affection migratory routes will lead them back to the locality from which they came.

Another favorite argument for the love of home and nesting ground is to be found in the fact that our early spring arrivals are often met with conditions that are most unfavorable. It is argued that birds show a desire to return to the familiar scenes of the previous summer because they push northward in the spring in spite of cold, sleet and snow. This argument, even more than the preceding, is extremely conjectural. It is only in a comparatively small number of species, and of many of those only in a certain number, that we have anything we might call a rapid pushing northward in spite of cold, sleet and snow. Furthermore, we must consider that the birth rate in birds is very limited. The majority of them lay less than twelve eggs to the set. This rate is very limited, especially when we consider that the destructive agencies in bird life are numerous. Beside the number of birds that are killed each season in migration, various animals depend largely upon birds for their existence. The young, too, require a definite period of time before they become sufficiently matured to perform a migration. Without here going into the principles of perpetuation, it is obvious that it is of importance to birds to return to their parental duties in spring as soon as possible. We do find it a quite general rule that several sets of eggs are hatched by one pair of birds each season, which

shows the utter necessity of rearing the first brood as soon as possible. Furthermore, it is believed that birds experience a physiological restlessness at the approach of the breeding season, as a result of which they are led on to commence their migrations. (38.)

Thus we have a sufficient explanation for the rapid northward movement in spring so often interpreted as showing a desire to be among the familiar haunts of the past season.

Prof. W. K. Brooks, of Johns Hopkins University, presents us with an argument that is of quite another form. He holds with Prof. Baird that the main factors governing spring migration are to be sought among the enemies to breeding (39). There is no doubt that birds nest where there is apt to be the least danger from enemies. In fact, from the standpoint of natural selection we should expect this. Areas with conditions destructive to bird life during the breeding season have always been known to be local, and it would be a questionable inference to say that the south as a whole, or even only generally, is dangerous to breeding birds. Yet this inference is necessary for the conclusions derived by Prof. Brooks, since we have migration occurring in a most orderly manner between the north and south as a whole, except in a few special cases. These will be treated separately.

Prof. Brooks makes an analogy between the migrations of birds and those of fishes (40). An examination of the two phenomena will show that they are of quite a different order, and hence will permit of no just analogy. The fishes referred to migrate regularly at the approach of the breeding season. In spite of many hardships they migrate inland from the ocean, often for several hundred miles, into the tributary streams. Here the food supply is far below the demand, and the question of food as an explanation fails. The eggs are deposited and left to the care of nature. Prof. Brooks probably makes his point that this migration is purely a case of depositing eggs in some place safe from enemies. It is not, however, a movement into a fertile area, nor has it a general direction for the class. The course followed is one that will bring them to a desired local area. While fish migration is thus a local phenomenon (if it is not Prof. Brooks does not give us such an impression), bird migration is a widespread

38. Stated by Merriam in a lecture delivered at the U. S. Nat. Museum, Apr. 3, 1886.

39. Brooks. *Pop. Sc. Mo.*, vol. 52, p. 784.

40. For my facts concerning the migration of fishes I am indebted to Prof. Brook's Article.

phenomenon and operates between faunal areas. In general the two phenomena are thus of such an entirely different order that they will permit of no just analogy.

Among birds there are two classes of migrations that are local. In the tropics and the warmer portions of the temperate zones we have a movement into the mountains in spring, and back again in fall. These movements, although local, are obviously movements between faunal areas, and hence are similar to the general migrations. The other form of local migration is found among birds that spend most of their time roving over the sea. These birds breed in favored localities upon rocky islands. We have here a case somewhat analogous to the migrations of fishes. It is not a phenomenon operating between faunal areas. These cases Prof. Brooks has used as furnishing an argument against the failure of food in the south. He has failed to see, however, that the food supply of these birds and those of our more migratory species is found under entirely different conditions. The food of the former consists of material that is abundant about these rocky islands throughout the year. It is not affected by the dry season, and hence it is not necessary that these birds should perform such extended migrations.

In so far as migration is concerned in the extreme northern portion of the geographical distribution of a species, there is probably an analogy between the movements of birds and those of fishes. When birds arrive in the north their movements are affected by local conditions. It is obvious that they will return to their old homes if these have been favorable; if not, they must seek new areas. It has been shown that the failure of food in the south will cause birds to move northward in spring. Investigations concerning migratory routes show that birds will be led back to the immediate vicinity of their old homes, where they seek breeding places that offer the best facilities. This latter portion of the movement may be analogous to that of fishes. The desire to secure safe breeding then becomes an important factor in migration, but only a modifying factor, a factor toward which we may look as a cause for the diversity and vastness which the phenomenon has attained. It may be one of the main factors concerned in the ultimate dispersion, and hence the increase of geographical distribution and extension of the migratory routes.

It has been shown that love of home and nesting ground, and the dangers of rearing young in the south, cannot be considered as principal causes for the spring migration. It has furthermore been shown that birds are quite dependent upon a particular kind

of food, and that in the case of the migratory birds their food fails in the north in winter and in the south in summer. Hence we may be justified in saying that the principal cause for migration, both in spring and fall, is to be sought in the failure of food.

The period of migration, however, in each season is of at least four months duration. In the spring it would seem that birds which arrive here find conditions for feeding less favorable than in the lands from which they have just departed. It has been shown, however, that it is advantageous for birds to return to their parental duties in spring as soon as convenient, and that the approach of the breeding season causes a physiological restlessness which sets them in migratory motion. In the fall, while we do find many of our birds departing at times when their food still seems to be abundant, we have life in nature continuously changing. Just as the year has seasons with a difference in life, so, too, the life of a summer is different at different times. Certain insects appear and disappear at more or less definite periods; plants, flowers, fruits and leaves all have their appointed times; days become longer and shorter, and the very atmosphere carries an essence, an inherent something, that seems to belong to a certain time of the summer. All of these phenomena are operating over a vast territory at the same time, affecting different birds in different ways, and setting countless numbers in motion simultaneously. While we may not be justified in saying that these changes in nature directly cause a dearth in the food supply of the migratory birds, they have been the forerunners, for ages past, of other changes the birds could not resist. Their influence upon birds has been operating since migration first took its origin, so that today they set the birds in motion instinctively.

Birds are set in migratory movement by a complex combination of changes in temperature, humidity and living nature. The cause for migration, however, is the failure of food in two widespread areas—the north and the south—at opposite seasons of the year.

CHAPTER III.

MIGRATORY ROUTES.

The theory that birds follow certain definite courses in their migrations, and that these courses are determined by the physiography of the countries through which they extend, may now be considered an established fact. A migratory route, excepting oceanic routes, consists of one or more physiographic features which together form an almost unbroken path from the breeding

district of an individual to its winter home. These paths consist of coast lines, river valleys, mountain ranges and island chains. To illustrate, a bird may start somewhere near the Alleghany Mountains, follow a course along the Appalachian System to any one of the streams originating at its southern extremity, follow this to the coast and the coast to some point in Florida or the West Indies. Others might start somewhere along the tributaries of the Potomac or the Hudson River or the Merrimac, and then down the coast.

Whereas, we have single birds and small groups starting from wholly different places, many will be brought together over the same course; a number of such courses lead to larger ones, until we finally arrive at a physiographic area that is thronged with migrants. Such an area is known as a migratory highway.

It is quite generally accepted that the principal highways of North America are the Atlantic Coast, the Appalachian Mountain System, the Mississippi River Valley, the Rocky Mountain System, the Pacific Coast and an island chain extending across Cuba from Florida to Yucatan.

Topographic features of less extent may be considered tributary highways, or main highways for local areas. The Great Lakes of North America offer some peculiar conditions in the migrations of those birds that spend the summer north of them and the winter in the south. At the Straits of Mackinac we have a narrow neck where the land to the north and south of the Lakes is not separated by considerable areas of water. We have here a mere point in the geography of North America toward which innumerable birds converge in their flight from one side of the Lakes to the other. At Spectacle Reef light-house, which lies just east of the entrance into the straits, there have been upwards of four and five hundred birds killed in one night by flying against the tower.

How in general the topographic features of a district influence lines of migration is well known to all bird students. A careful study of the data presented in Prof. Cooke's Report on Migration in the Mississippi Valley shows, as we should expect, that birds resident in Wisconsin use the Mississippi River as a highway (41). Furthermore, after following this river north to the mouth of the Rock River, it is a noteworthy fact that immense numbers of our birds enter the state along a course following the Rock

41. Cooke. Report on Bird Migration in Miss. Valley. U. S. Dept. Agr. Bull., No. 2, 1888.

River. A study of the movements of the bluebird north of St. Louis in the spring of 1885 shows that there is a regular chronological succession of data extending northward along the water courses (42). Another interesting feature is to be seen in the fact that those birds which followed the main highway reached higher latitudes in the same length of time than those which turned off to follow some tributary highway. It would thus seem evident that the birds reported from either side of the Mississippi River had been following it during some previous part of the journey. A study of the records of a number of the other birds has shown results that are very similar.

In connection with this work telescopic observations were begun at the Washburn Observatory at Madison, in the spring of 1898, and were continued through 1899 and 1900. During the spring of 1900 interested persons from our western universities were asked to co-operate in the collection of data. The result was excellent.

The following directions were sent to all who acknowledged their willingness to assist:

BIRD MIGRATION.

Directions for Observing with Telescope.

The Instrument.

Should be one with an objective ranging somewhere between 2 and 6 inches. The eye-piece should be supplied with 2, or if possible 4, hair-lines crossing in the center, thus dividing the field of vision into quadrants or octants.

Time of Observation.

Begin to observe as soon as the moon is high enough to come distinctly into the field of vision, and continue until morning.

To Begin the Observations.

Focus the telescope on the moon with the point of intersection of the hair-lines on the moon's center. Turn the eye-piece so that one of the lines lies parallel to the direction in which the moon is moving across the heaven. Now turn to your note paper. At the head of this write the date, locality, direction of wind, and weather in general. Just below this draw a circle, putting in the hair-lines as they appear through the telescope. Number them, beginning at the right hand side of the one you have placed parallel to the direction of the moon and continuing counter clock-wise. See figure below:

The Observations.

(It is a difficult task to observe and write out the observations at the same time, and, also, it will tire the eyes to look at the bright moon too

42. The movements of the bluebird are recorded in Cooke's Report on pages 293 and 294.

long at one stretch. It is, therefore, advisable to have two observers so as to relieve each other every half hour or even every fifteen minutes, the one writing the observations while the other is observing).

The time should be divided into periods of fifteen minutes each, *i. e.*, the observations should be made for periods of this length.

The following data should be noted with every bird that crosses the field of vision:

The number and approximate tenths (as indicated by the hair-lines) at which the bird enters and likewise at which it leaves the field of vision.

The speed at which it is flying—slow, fast, like a shot, etc., etc.

His approximate size as compared to Goldfinch (size 1), Robin (size 2), and Crow (size 3). If slightly smaller add — sign, if larger a + sign.

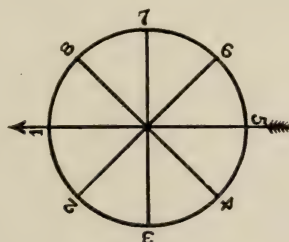
State if the bird is out of focus.

State if its wing-strokes are plainly seen.

Other remarks that you may think of value.

The notes should look like this:

Madison, Wis., May 14, 1900. Warm, with quite strong southwest wind; sky perfectly clear.



Period, 8:15—8:30.

I. In.	II Out.	III. Speed.	IV. Size.	Remarks.
...	...			
4.6	1.2	very slow	2	Small hawk soaring.
3.8	8.1	fast	1	Flight like goldfinch.
3.8	8.1	fast	1	Flight like goldfinch.
5.2	8.8	very fast	1	.....
4.1	8.5	fast	2	Curved below center.

III. and IV. are of less importance than I. and II.

These instructions resulted in eight excellent sets of data, and much credit is due Mr. Leon J. Cole of Ann Arbor, Faculty University of Michigan; Mr. H. S. Warren, of Detroit, Secretary Michigan Ornithological Society; Mr. William James Rice, Faculty Lake Forest University; Mr. O. S. Dart, student University of Minnesota, and Mr. Wegemann, student Beloit College, and their assistants, for their hearty co-operation in the collection of these data. A set consisting of one evening's observations was contributed from each of the following places: Ann Arbor, De-

troit and Minneapolis; from Lake Forest there were two; and the writer, with the assistance of Mr. Wegemann, obtained three at Beloit, while Dr. Libby conducted the observations at Madison. The data received from Michigan deserve special mention for the care with which they were collected.

From the telescopic observations it appears that birds are quite, we might even say, exceptionally dependent upon their respective migratory routes. Curves drawn from such data representing the numbers of birds flying in periods of fifteen minutes show that physiographic features are followed very closely as guide-lines (Plate I.). The Beloit curves show a sudden increase in the numbers of birds observed as the telescope gradually comes to point more nearly over the course of the Rock River. The observatory at Beloit is situated on a slight elevation just east of the river, so that the telescope points away from the river in the early evening. The river at this point flows very nearly south, while just outside of the southern border of the city it takes a course a little west of south. These curves again show the extreme importance of a water course in migration. In the foregoing consideration it has been stated that a great many of the birds of Wisconsin enter the state along the course of the Rock River. The difference between the number of birds flying over the immediate course of the river and those flying to one side of it, as shown by the plates, indicates that topographical lines are followed very closely here. There is an exceptional concentration of the number of birds flying over the immediate course of the river.

While the curves drawn for Madison do not bring out this feature in as striking a contrast as do those for Beloit, the observations show that there is a decrease in the number flying when the field of observation has passed beyond the Madison Lakes and Yahara River System. By reducing the different plots for Madison to the same number of hours after moon-rise, we obtain a comparative view of the numbers of birds flying over the same physiographic features (Plate II.). Although the curves show considerable diversity, they seem to reach maximum points between two and three, four and five, and seven and eight hours after moon-rise. This, however, is not universally true. The lake region about Madison, with its extremely diverse topographical features, makes the problem a most complex one in this region. From investigations carried on here for over four years it is quite safe to conclude that the greatest flights are found to occur when the telescope points over the lake system—that is, before the moon has traveled over the sky a distance of five hours. Plate III.,

which shows the observations of three evenings combined into a single plot, brings out this feature most strikingly.

In the first observations collected here the general conclusion suggested itself that birds discontinue their migrations soon after midnight, but the comparison of these observations with those from other places points to the conclusion that the topography rather than the time of night determines the number of birds flying.

If the curves drawn from data collected at Detroit, Michigan (Plate I.) are compared with the map of Michigan, it will be seen that the maximum of the curve is reached as the telescope points more nearly along the course of the Detroit River. The telescope used was situated about three-fifths of a mile from the river, on the western side. During the early part of the evening the instrument pointed over the river at an angle; toward 10 o'clock it gradually came to point along the course of the river, and then gradually moved away from the river again. The curve shows a more or less general increase toward 10 o'clock and a gradual decrease after that time, until it finally falls even lower than in the early part of the evening, when the telescope pointed across the river.

At Ann Arbor the map of Michigan shows the river so situated with reference to the place of observation that we might expect the highest point in the curve in the early part of the evening. It begins high and falls gradually as the telescope moves away from this area (Plate I.).

The topography surrounding Lake Forest, Illinois, makes the conditions influencing the migratory movement much the same as those for Detroit. Lake Forest is situated on the southwest shore of Lake Michigan. During the early part of the evening the telescope cuts the shore line of the lake at an angle; later it points more nearly in a line with the shore, after which it gradually moves away from this area again. These are in general the same conditions that prevail at Detroit, and the curves for the two places are, as we should expect, almost precisely the same. The time of observation at Lake Forest extended only to 11 o'clock; we might predict, however, that were they continued the curve would fall considerably lower (Plate I.).

The Detroit data show other interesting features that conform entirely with the theory here advanced. Out of 111 birds observed 74 were traveling northeast, 13 north-northeast, 11 east-northeast, 4 north, 5 north-northwest, 3 northwest, and 1 southeast. In other words, 66 2-3 per cent of all the birds recorded were flying northeast and about 21 2-3 nearly northeast, leaving only about 12

per cent that did not take a general northeasterly direction. The course of the Detroit River is southwesterly, and Mr. H. S. Warren writes that it seems evident that the birds were following the river. The regularity of the direction maintained should dispel all doubts to the contrary. An interesting feature now presents itself in connection with the peculiar topography just northeast of Detroit. The river here gradually broadens to form Lake St. Clair. While 66 2-3 per cent of the birds maintained a northeast direction, 21 2-3 diverged slightly to either side in about equal proportion, from which we might infer that the latter were beginning to direct their courses along opposite shore lines of Lake St. Clair. If this be the case, it shows how very closely birds follow topographic lines. Then, again, it is rightly maintained that birds can see great distances, from which we should expect that unless they follow the coast lines of the lake very closely the telescopic observations collected here would show a great diversity in the directions of flight, since the birds would then cross from Lake Erie to Lake St. Clair rather promiscuously. Under such circumstances there would be very little evidence of concentration along special topographical lines.

A comparison of the plots for Beloit and Madison show that at Beloit the maximum in the curve is reached much more suddenly than at Madison (Plates I. to III.). This, again, according to our theory, is readily explainable in each case by the difference in the surrounding topography. The Lake System at Madison is broad and has the topographic features that influence lines of migration extending over a wide area. The Rock River at Beloit is narrow and the surrounding topography rather uniform. The curves for the latter place consequently rise more suddenly and at the same time vastly higher, the migrating stream being confined to narrower limits.

The birds noted to either side of the more important physiographic features are probably such as have departed from the main highway and are following courses of lesser importance, in many instances such as will probably lead them to a summer home in the vicinity. In fact, Plates IV. and V., illustrating the direction of flight at Beloit, seem to show that outside of the main highway (i. e., during the early part of the evening, when the telescope pointed away from the river) there is greater diversity in the directions followed. When the telescope points away from the main highway, the fact that fewer birds were seen and that the directions followed were more diverse would point to the con-

clusion that these birds were following migratory routes of lesser importance.

A feature of special note in Plate VIII., showing the directions of flight at Madison, is that there are two general directions followed here. From the preceding discussion, in which it was found that physiographic features are followed very closely, we might infer that the peculiar lake topography about Madison has brought about these two general directions.

It is, however, noteworthy in the plate that of these two directions one predominates in April and the other in May, though the percentage of the May-flight, if we may refer to it by that name, is not as marked over the April-flight in May as in the latter over the May-flight in April. Of the more common migratory species of this region something over 70 per cent of those that arrive here in April, and perhaps the first few days in May, are summer residents. Of those that arrive after that time about 60 per cent are mere migrants for this region; that is, they pass through here to breed farther north. Since these figures are only rough estimates, and furthermore would need to be modified considerably by the abundance of the number of individuals in the species, we can only hint at a possible interesting line of investigation that suggests itself here. It may be objected that this consideration is at present too vague even to allow of suggestion. However, if we take the list of one hundred species, with the dates of arrival and departure, prepared by Mr. F. M. Chapman (43), it will be seen that the percentages given above have not been overestimated in favor of the principle to be involved (44). About 64 of these 100 species arrive here before the end of the first week in May, and 36 after that date. Of the former, 52, or $81\frac{1}{4}$ per cent, are summer residents; of the latter, only 14, or about 38.8-10 per cent, are summer residents, the remainder breeding farther north. Moreover, the proportion of the number of individuals in those species that arrive here in May and are summer residents is in all but a few cases far below those that merely pass through here. Of fourteen summer residents that arrive here in May about eight are generally included among the rarer species, while only six are abundantly found, which would seem to show that in all probability the greater number of birds that fly through Madison in May breed farther north, and hence that different routes are followed by the two groups of birds.

43. Handbook of Birds of East. N. A., N. Y., 1897, pp. 15-17.

44. This list has been slightly modified by notes taken in Wisconsin in recent years.

The topography to the north of Madison shows that Lake Mendota at one time had an outlet northwest into the Wisconsin River, and that a little to the northeast of this area there is a broad valley that once connected Rock River with Green Bay (45). A possible conclusion suggests itself now as an explanation of the two directions noted at Madison, namely, that they are the result of these two physiographic features.

These conclusions point to a feature of special interest which offers a most important field for investigation. In general the families Mniotiltidæ and Turidæ, and the order Limicolæ breed in the far north. Among the others certain species breed abundantly up to a definite latitude, beyond which the number of species and individuals of these more southern birds decreases directly as the distance increases. Granting Weismann's theory in so far as migration is a development, resulting from dispersion, as we must, and Merriam's theory that there are two centers of dispersion in North America (46), it would seem evident from the foregoing considerations that birds dispersing from the north southward, in the same region, may have been influenced by different topographic features from those that dispersed from the south northward.

From a detailed study of the geographic distribution of birds, their lines of migration, and the degree of perfection which the phenomenon has attained in the different groups, we may arrive at data which will lead to the correct conception of the origin of migration, and from which we may even be enabled to work out the evolution of the phenomenon in the different groups.

Prof. Baird has traced the lines of dispersion of a number of birds of eastern North America westward and northward, almost to the Pacific Coast in the northern part of the United States. He found that in dispersing they followed the Missouri and Platte Rivers from the Mississippi River and, what is most remarkable, that they followed these same rivers in migrating from these summer homes to their winter homes in Mexico, instead of moving directly southward through California (47). This is excellent evidence that the routes followed in migration are the lines of dispersion followed when birds first moved out from their original faunal area. Moreover, the main highways at present are situated along courses that are especially favorable as lines

45. Chamberlin. Geol. of Wis. Survey of 1873-1879, vol. 1. p. 284.

46. Merriam. U. S. Dept. of Agri., North Amer. Fauna Bull., No. 3, pp. 19-22.

47. Baird. Am. Jour. of Sc., 1866, p. 78.

of dispersion, or where on account of barriers these courses would be the only ones likely to be followed. Thus the wooded streams of our river valleys and the salt marshes of the coast line offer an abundant supply of food, and quite generally environmental conditions that are favorable to birds of every group. Coast lines furthermore present the ocean on one side as a vast barrier; likewise island chains, while they present a favorable food supply on the one hand, have the ocean to either side as a vast barrier. Mountain ranges, again, with their difference in faunal areas, act as a barrier to certain groups, directing their movements along the more fertile foothills; as an inducement to others since they are enabled to find their accustomed faunal areas winding their way through other faunal areas that would be anything other than an inducement.

It now becomes evident that birds will return to the proximity of their old homes even in the absence of home affection.

The fact that some few birds seem to follow a different course in fall from the one followed in spring might at first appear to offer difficulties to the principle evolved above. If it be remembered, however, that migration originated as a result of dispersion, and in all probability of successive dispersions of the same species both from the north and the south, it is obvious that in the south different physiographic features may have influenced the birds from those that influenced them in the north, and so lead to a circular route. These cases must not be confused with those referred to by Prof. Baird, since in the latter the birds were already extensive migrants, they were beyond the stage of the acquisition of the habit, and present us merely with a case of the extension of a migratory route under conditions already familiar to them.

In connection with work of this nature two theories have been presented, at different times, regarding a sixth sense by means of which birds find their way between their summer and winter homes. The first of these, that of Dr. A. von Middendorf, has already been shown to be a fallacy (Historical Review, pp. 4-5, *ante*). The second is the result of careful investigations upon carrier pigeons. Capt. G. Reynaud, who is the author of this theory, has formulated what he terms a "law of retracement," or "law of reverse scent" (48). He says: "When the time for departure is come, birds of the same species, inhabiting the same region, come together for the journey. Those that have already

48. Smithsonian Report, 1898, pp. 481-498.

made the voyage take the lead and retrace the path by which they came (49). The younger birds, born since the last journey, confine themselves to following their elders, and when, some months, later, it becomes time to return, they are able in their turn to follow in a reverse direction the journey previously made."

However, since migration is the result of dispersion, and dispersion takes place very gradually, comparatively only a very short distance each year in the extension of a migratory route, the probabilities are that the features along this route are very familiar to the older birds. With regard to those that were born since the last journey, there are again conditions that make a sixth sense entirely unnecessary. Brewster claims that young birds migrate by example, and his claims are upheld by the majority of leading ornithologists (50). This being the case they can readily join the migrating stream overhead and without any great effort follow the general movement. When we consider that at Beloit from sixty to eighty birds crossed the field of vision in fifteen minutes, showing that there is a regular stream of migrants along the highway, it leaves little room for doubting the ability of young birds to find their way without the aid of a sixth sense.

CHAPTER IV.

THE MANNER OF MIGRATION.

The movements and habits of birds differ in different species, during the migratory season, with regard to one another and to their environment. These relations have been designated by the term Manner of Migration.

The problems arising in this connection may be classified under three main heads: (1) with regard to their associations, which concerns itself with the questions of the numbers and species associated during the migratory season, the relation of adults to young, and the relation of males to females; (2) with regard to the environment, which concerns itself with the questions of special food habits, and meteorological influences; (3) with regard to the manner of progressing from place to place, which concerns itself with the time of migration—day or night,—the relative successive positions, the speed and altitude attained, and kindred phenomena exhibited during the time birds are in actual

49. This he endeavors to show is accomplished by a sixth sense, a sense of orientation.

50. Brewster. Mem. Nutt. Ornith. Club, No. 1, 1886, p. 12.

migratory motion. The following discussion will deal in the main with such of these problems as can be solved by means of the telescope supplemented by field observations.

Numbers Associated in Migration.—It has been known for a long time that migrations occur both during the day time and during the night, but it is only within comparatively recent years that a fair conception of the extent to which the nocturnal migrations take place has been attained. Prof. A. S. Flint of the Washburn Observatory has calculated from data collected by Dr. O. G. Libby in 1897, that nine thousand birds per hour passed within the arc of a circle subtended by the angle through which the telescope passed during the entire period of observation. This gives us a fair mathematical estimate of the magnitude of the nocturnal movement.

The Altitude Attained in Migration.—Estimates of the altitude of migration as obtained by means of the telescope show that former investigators have placed their estimates far too high. In the observations taken at Beloit from 2:00 to 3:30 A. M. the telescope made an average angle of about fifteen degrees with the horizon. The telescope at this time was about one mile from that portion of the river over which the birds were observed. This means that the majority of them were not over fifteen hundred feet above the surface of the earth.

Estimates from data collected at Detroit show the flight to have been slightly higher, but still far below the estimates of former investigators. Mr. H. S. Warren writes from that place as follows: "The observations were taken at the Cartwright observatory located about three-fifths of a mile from the river. The telescope, a 6-inch refracting instrument, equatorially mounted with an 8-inch focus, was at an average angle during the period of observation, of about thirty degrees. If the birds that were traveling northeast, which numbered considerably more than one-half of all noted, were following the course of the river, which seemed evident, they must have been somewhat more than one-half mile above the surface."

The telescopic observations show that there may be a zone of considerable depth, birds choosing variable altitudes in which to perform their migrations, but by far the greater number do not attain an altitude much over one-half mile from the earth's surface.

Associations of Individuals and Species.—A more detailed consideration of the telescopic observations collected for this thesis tends to establish, with some modifications, the results obtained by

Dr. Brewster at Point Lepreaux Light-house in 1881 (51). No set of data or description can convey so good an idea of the actual state of affairs as the observation of the phenomena themselves through the telescope. With regard to nocturnal migrants the following general conclusions are apparent: (1) that they perform their journeys both singly and in compact flocks, the different individuals and groups being more or less united into straggling bands or streams; (2) that single individuals and groups fly independent of one another, but to some extent may be dependent upon the general movement of the stream; and (3), that there is a great diversity of species and individuals associated together in migration.

The data for any one evening that has seemed favorable for migrating birds will establish these general statements. (See data in appendix.) The continuous stream-like movement over some routes has already been referred to and it will only be necessary to call attention here to the extent of these bird-streams, and to the fact that they are composed both of single individuals and flocks. Throughout the observations when the number of birds was not exceptionally large, from two or three to about fifteen for a period, it was very noticeable that the majority of birds were not collected into compact flocks. Although it was not uncommon to have several appear in fairly rapid succession, it was more often the rule to see them following one another in a straggling manner; impressing the observer with the idea of a regular straggling stream, such as one might see anywhere near a school just after the hour of dismissal.

From the entire set of observations collected with the telescope, the immense numbers of birds recorded when the field of vision extended along a highway, and the apparent regularity with which the birds passed—in some instances for several hours at a time,—it is quite evident that along the main highways and the more important tributaries birds fly in such numbers that for miles we have one long, almost continuous stream of birds. When we consider that from fifty to eighty birds were recorded on the Rock River in fifteen minutes, that the average number remained high for more than an hour, and that these birds must have departed from a similar stream of even greater magnitude along the Mississippi River, the nocturnal movement becomes not merely interesting but marvelous.

Although Dr. Brewster has not found it so at Point Lepreaux, telescopic observations tend to show that certain individuals may be collected into fairly compact flocks, numbering from a few to a large number. Thus in the data collected at Beloit, May 12, 1900, from 1:45 to 3:00 A. M., there are five records (see appendix, pages 238 to 240) where birds appeared in comparatively large numbers, in such rapid succession—often a number in the field at the same time—that it leaves little room for doubting that these birds did belong to fairly compact flocks. To say that in some instances as many as ten or more birds crossed the field in less than one-third that many seconds would not be an overstatement of the case. Moreover, the actual number recorded must have been only a small number of all that were associated in one flock. In fact data obtained by listening for bird calls on dark nights seem to indicate that it is not an uncommon occurrence for nocturnal migrants to fly in fairly compact flocks.

That flocks and single individuals flying side by side, are moving independent of one another is evident from the range of speed exhibited. Throughout the observations it was common to see birds, at times, apparently side by side, flying at rates that varied from the extremely slow to the very highest rate of speed. On the other hand it is quite obvious that the general movement of the stream may have a guiding influence to such birds as have had little or no experience.

Although it is only in rare instances that species can be identified, the general outline, the size and the motion of the birds as they are seen silhouetted against the moon leaves little doubt to the observer that he has a diversity of species passing through the field of vision. The large number of routes that lead to the more important highways would bring individuals from diverse regions together along these courses. On the other hand, birds that become associated do not necessarily continue thus to the end of their journey. Dr. Brewster makes the following statement in this connection: "During even its earliest stages their members must become separated from one another and become associated with birds of the same or different species belonging to other flocks which may have started from various localities, but which are traveling in the same direction and along the same or parallel paths" (52).

As to how these birds separate again, Dr. Brewster says: "An answer to this question was suggested at Point Lepreaux by the

52. Brewster. Mem. Nutt. Ornith. Club, No. 1, 1885, p. 13.

fact that, while many species of birds arrived together on the same night, and mingled indiscriminately in the neighboring woods during the following day, they did not invariably depart together nor in the same direction. This leads me to believe," he says further, "that similar places along every route constitute what may be called stations or points of departure" (53). Field observations about Madison show results that are very similar. A careful study of the movements of the tree sparrow and the slate-colored junco was made during the spring of 1900. Their haunts were visited each morning on the eastern border of Lake Wingra and on the University Drive along Lake Mendota. Each day there was either an increase or a decrease and it was plainly noticeable that there were several sets of individuals intermingled. From their actions it is quite easy to distinguish those that arrive the preceding night from those that were there the day before. These observations, however, would seem to indicate that such points of departure are not limited to promontories extending into the sea, points of timber bordering extensive plains or the extremity of mountain ranges, where the migrating tide hesitates before venturing on the dangerous stage ahead, as has been suggested by Dr. Brewster (54), and previously, in 1846, by I. F. Naumann (55). These investigations show that such stations may occur almost anywhere along a migratory route rather than at certain limited points.

Birds do not fly to some desired resting place in one night and then pursue their flight to another the next night, nor do they necessarily fly throughout the entire night and then stop at the first convenient place in the morning. The simple truth here is that birds fly as far during one night as they find convenient, the distance being determined by immediate environmental influences. In the observations made at Beloit there were certain times when there seemed to be an undue proportion of birds so close to the telescope that they appeared out of focus. The directions of flight of these individuals as illustrated by plates IV-VII are entirely out of keeping with the general course. A conclusion suggests itself here that these birds had departed from the migrating stream overhead and were seeking suitable resting places.

53. Brewster, Bull. Nutt. Ornith. Club, No. 1, page 13.

54. Ibid.

55. Hist. Review, p. 180.

Appendix.

For the method of observation see pages 198 and 199. The meteorological data, except those for Detroit, Ann Arbor, and Lake Forest, have been taken from the records at the Washburn Observatory at Madison. The temperature in each case is for 9:00 P. M., the direction of the wind for 2:00 and 9:00 P. M., stated for example West to Northwest—West at 2:00 and Northwest at 9:00 P. M. When only one direction is given that was the direction for the entire day.

MADISON, Wis., April 9, 1898.

METEOROLOGICAL DATA.

Wind—North Northwest, velocity 5.

Temperature —44. 3°.

Atmosphere—sprinkling at 2:00 P. M., fair at 9:00.

Total number of Birds observed from 9:45 P. M. to 11:30 P. M.—44.

9:45 to 10:00—	in 3.0—out 5.0.	
	in 3.0—out 7.0.	
	in 3.0—out 8.0.	
	in 4.0—out 7.0.	
	in 3.0—out 8.0.	
	in 4.0—out 6.0.	
	in 3.0—out 8.0.	
	in 4.0—out 8.0.	
	in 3.0—out 8.0—Total 9.	
10:00 to 10:15—	in 3.0—out 7.0—Robin.	
	in 3.0—out 7.0—out of focus.	
	in 2.0—out 7.0.	
	in 2.0—out 6.0.	} Geese side by side.
	in 2.0—out 7.0.	
	in 3.0—out 8.0.	
	in 3.0—out 7.0.	
	in 3.0—out 5.0.	
	in 3.0—out 8.0—Total 9.	
10:15 to 10:30—	in 2.0—out 8.0.	
	in 2.0—out 8.0.	
	in 2.0—out 7.0.	
	in 1.0—out 5.6.	
	in 3.0—out 8.0.	
	in 3.0—out 7.8.	
	in 3.0—out 5.0.	
	in 2.5—out 8.9.	
	in 3.7—out 5.5—Total 9.	
10:30 to 10:45—	in 3.7—out 6.9.	
	in 2.0—out 8.0.	
	in 3.5—out 6.5.	
	in 4.3—out 7.7.	
	in 1.5—out 7.7.	
	in 3.5—out 8.5.	
	in 5.1—out 7.5.	
	in 3.0—out 1.0.	
	in 3.1—out 5.7.	

	in 5.7—out 7.0.
	in 2.9—out 7.8.
	in 3.5—out 6.3.
	in 4.2—out 5.6—Total 13.
10:45 to 11:00—	in 8.0—out 6.0.
	in 3.3—out 7.5.
	in 2.6—out 7.6—Total 3.
11:00 to 11:15—	in 0.0—out 0.0—Total 0.
11:15 to 11:30—	in 2.5—out 7.6—Total 1.

MADISON, WIS., Apr. 10, 1898.

METEOROLOGICAL DATA.

Wind—North to northwest, velocity 4.

Temperature—45. 8°.

Atmosphere—Cloudy at 2 P. M. to clear at 9 P. M.

Total number of birds observed from 12:45 P. M. to 3:00 A.M.—6.

12:45 to 1:00—	in 0.0—out 0.0—Total 0.
1:00 to 1:15—	in 3.5—out 8.6—Slow—Size 1—Total 1.
1:15 to 1:30—	in 3.1—out 8.2—Out of focus—Total 1.
1:30 to 1:45—	in 4.4—out 8.1—Total 1.
1:45 to 2:00—	in 3.2—out 7.9—Flying leisurely.
	in 3.5—out 7.2—Faster—Same species as preceding—Total 2.
2:00 to 2:15—	in 0.0—out 0.0—Total 0.
2:15 to 2:30—	in 5.2—out 7.9—Total 1.
2:30 to 2:45—	in 0.0—out 0.0—Total 0.
2:45 to 3:00—	in 0.0—out 0.0—Total 0.

MADISON, WIS., May 5, 1898.

METEOROLOGICAL DATA.

Wind—North to southeast, velocity 4.

Temperature—46. 5°.

Atmosphere—Cloudy to clear.

Total number of birds observed from 8:30 P. M. to 11:00 P. M.—13.

8:30 to 8:45—	in 4.5—out 6.5—Slow — Long wing-strokes—Sailing.
	in 4.4—out 7.3—Out of focus—8 minutes of this period missed—Total 2.
8:45 to 9:00—	in 0.0—out 0.0—Total 0.

11:00 to 11:15—in 8.5—out 3.5.
in 7.5—out 3.8—Size 2.
in 7.5—out 3.8.
in 7.5—out 4.2.
in 7.5—out 3.6.
in 6.7—out 3.0—Size 2.

	in 6.3—out 4.5.	
	in 6.5—out 4.8—Total 8.	
11:15 to 11:30—	in 7.1—out 3.2—Total 1.	
11:30 to 11:45—	in 7.3—out 3.4.	
	in 6.3—out 3.2.	
	in 6.7—out 3.8.	
	in 8.3—out 2.4.	
	in 6.4—out 4.2.	
	in 7.3—out 3.0.	
	in 6.4—out 3.7.	
	in 6.5—out 2.5.	
	in 6.8—out 3.9.	
	in 7.3—out 3.4.	
	in 6.1—out 3.3.	
	in 6.3—out 4.5—Total 12.	
11:45 to 12:00—	in 5.5—out 3.1.	
	in 5.9—out 2.1.	
	in 6.5—out 3.5.	
	in 6.9—out 3.2.	
	in 5.4—out 3.1.	
	in 5.0—out 2.3—Total 6.	
12:00 to 12:15—	in 6.7—out 1.2.	
	in 6.5—out 2.3.	
	in 6.4—out 4.1—Total 3.	
12:15 to 12:30—	in 6.4—out 3.2.	
	in 5.4—out 3.2.	
	in 5.5—out 2.5—Total 3.	

MADISON, WIS., Sept. 24, 1898.

METEOROLOGICAL DATA.

Wind—West to southwest, velocity 4.

Temperature—63. 3°.

Atmosphere—Cloudy to clear.

Total number of birds observed from 7:15 P. M. to 11:30 P. M.—46.

7:15 to 7:30—in 6.3—out 3.6—Total 1.

7:30 to 7:45—in 4.2—out 2.1.

in 3.5—out 2.6.

in 5.9—out 7.9.

in 5.5—out 8.3.

in 5.8—out 3.9.

		in 6.8—out 2.1	} Slow—Same species — meadowlark(?).
		in 5.3—out 7.1	
		in 4.6—out 1.8.	} Fast
		in 5.9—out 3.8	
			Very slow—About 3 sec. to cross field.
		in 5.9—out 1.1—Total 10.	
7:45 to 8:00	—in 4.5—out 2.1.		
	in 5.3—out 2.5—Total 2.		
8:00 to 8:15	—in 5.5—out 1.1.		
	in 4.8—out 2.8.		
	in 4.8—out 1.9.		
	in 5.3—out 2.7.		
	in 5.0—out 1.8.		
	in 0.0—out 3.1.		
	in 4.5—out 2.6.		
	in 5.3—out 2.2—Total 8.		
8:15 to 8:30	—in 6.8—out 0.0—Curved over center.		
	in 6.2—out 8.9—Total 2.		
8:30 to 8:45	—in 4.3—out 2.0.		
	in 5.3—out 8.9—Like a shot.		
	in 4.6—out 1.5.		
	in 5.8—out 1.3—Total 4.		
8:45 to 9:00	—in 6.2—out 1.8	} Same species.	
	in 4.4—out 1.8		
	in 6.2—out 1.5		
	in 6.4—out 1.2.		
	in 4.5—out 1.1—Total 5.		
9:00 to 9:15	—in 6.0—out 1.5.		
	in 4.6—out 2.9—A mere blur.		
	in 4.6—out 1.6.		
	in 5.8—out 1.1—Swift, like a shot.		
	in 8.0—out 3.6—Total 5.		
9:15 to 9:30	—in 0.0—out 0.0—Total 0.		
9:30 to 9:45	—in 6.3—out 8.4.		
	in 7.1—out 3.8.		
	in 3.7—out 8.9—Total 3.		
9:45 to 10:00	—in 0.0—out 0.0—Total 0.		
10:00 to 10:15	—in 5.5—out 8.6.		
	in 2.5—out 5.8—Total 2.		
10:15 to 10:30	—in 0.0—out 0.0—Total 0.		
10:30 to 10:45	—in 5.8—out 7.8.		
	in 1.9—out 3.8.		

		in 5.0—out 1.0—Total 3.0
10:45	to 11:00—	in 0.0—out 0.0—Total 0.0
11:00	to 11:25—	in 0.0—out 0.0—Total 0.0
11:25	to 11:50—	in 4.6—out 2.4—Total 1.0

MADISON, WIS., Sept. 25, 1898.

METEOROLOGICAL DATA.

Wind—South, velocity 8.

Temperature—63. 6°.

Atmosphere—Clear.

Total number of birds observed from 6:45 P. M. to 8:55

P. M.—2.

6:45 to 7:00—in 0.0—out 0.0—Total 0.

7:00 to 7:15—in 0.0—out 0.0—Total 0.

7:15 to 7:30—in 5.0—out I.O.

in 7.3—out 5.6—Total 2.

7:30 to 7:45—in 0.0—out 0.0—Total 0.

7:45 to 8:00—in 0.0—out 0.0—Moon partly obscured by clouds—Total 0.

8:00 to 8:15—in 0.0—out 0.0—Total 0.

8:15 to 8:30—in 0.0—out 0.0—Total 0.

8:30 to 8:45—in o.o—out o.o—Total o.

8:45 to 8:55—in 0.0—out 0.0—Total 0.

MADISON, WIS., Apr. 25, 1899.

METEOROLOGICAL DATA.

Wind—North northwest to southeast.

Temperature—66. 8°.

Atmosphere—Clear.

Total number of birds observed from 8:37 P. M. to 11:30

P. M.—7.

8:37 to 8:45—in 3.8—out 8.9—2 birds at high speed.

in 4.1—out 8.5.

in 3.9—out 8.5—Curved below center—Total

4.

8:45 to 9:00—in 0.0—out 0.0—Total 0.

9:00 to 9:15—in 0.0—out 0.0—Total 0.

9:15 to 9:30—in 4.2—out 7.8.

in 2.0—out 5.0—Slow—Wing-beats slow—To-
tal 2.

9:30 to 9:45—in 0.0—out 0.0—Total 0.

9:45 to 10:00—in 0.0—out 0.0—Total 0.

10:00 to 10:15—in 0.0—out 0.0—Total 0.

10:15 to 10:30—in 7.6—out 1.3—Total 1.

MADISON, WIS., May 22, 1899.

METEOROLOGICAL DATA.

Wind—Northeast to east southeast, velocity 4.

Temperature—54. 8°.

Atmosphere—Clear.

Total number of birds observed from 8:30 P. M. to 10:45 P. M.—61.

8:30 to 8:45—in 0.0—out 0.0—Direction missed.

in 8.6—out 3.5.

in 1.0—out 5.0—Flight like meadowlark.

in 2.6—out 7.4—Same as preceding.

in 1.0—out 5.4.

in 4.0—out 5.0—Total 6.

8:45 to 9:00—in 4.5—out 7.5.

in 3.0—out 8.0.

in 4.5—out 7.5—Sailing.

in 6.0—out 8.5.

in 4.5—out 6.0—Curved around center.

in 5.0—out 7.0.

in 8.0—out 6.0—Size 3.

8:45 to 9:00—in 2.0—out 6.0—Dropped through Field—Total 8.

9:00 to 9:15—in 4.0—out 0.0.

in 1.0—out 5.0.

in 2.0—out 4.5.

in 7.0—out 5.4.

in 7.2—out 0.0.

in 3.7—out 8.5.

in 8.5—out 6.0.

in 6.5—out 4.5—Total 8.

9:15 to 9:30—in 3.6—out 7.0.

in 1.0—out 5.0.

in 8.5—out 5.2.

in 3.5—out 8.0—Out of focus.

in 1.0—out 5.2.

in 1.0—out 5.0—Sailing in the wind—Total 6

9:30 to 9:45—in 1.0—out 4.8.

in 4.3—out 8.5—Swamp blackbird(?).

in 4.5—out 8.5.

	in 0.0—out 0.0—Pigeon(?), long, pointed tail.
	in 3.8—out 1.5.
	in 8.5—out 7.1.
	in 7.0—out 1.0—Out of focus—Total 7.
9:45 to 10:00—	in 7.3—out 3.7—Curved over center.
	in 8.5—out 5.0—Robin(?).
	in 8.5—out 7.0.
	in 1.5—out 7.0—Out of focus.
	in 8.6—out 4.5
	in 1.0—out 4.5
	in 8.5—out 4.5
	in 0.0—out 0.0—6 minutes lost—Total 7.
10:00 to 10:15—	in 0.0—out 0.0—8 minutes lost.
	in 1.0—out 3.5.
	in 1.5—out 5.0.
	in 8.5—out 5.0—Curved below center.
	in 7.5—out 5.0—Swift—Snipe(?).
	in 8.7—out 7.0—Snipe(?).
	in 8.5—out 4.8—Out of focus—Total 6.
10:15 to 10:30—	in 7.5—out 5.0.
	in 8.5—out 4.5.
	in 8.3—out 4.8.
	in 8.7—out 4.8.
	in 1.3—out 3.5—Size 1.
	in 4.3—out 2.0.
	in 8.9—out 3.0—Long tail.
	in 8.9—out 3.5.
	in 8.5—out 4.8—Swift, speed like a shot—Total 9.
10:30 to 10:45—	in 1.0—out 4.0.
	in 1.0—out 5.2.
	in 7.0—out 5.0.
	in 1.0—out 4.0—Duck—Total 4.

MADISON, Wis., Apr. 10, 1900.

METEOROLOGICAL DATA.

Wind—North northeast to east, velocity 6.

Temperature—29. 2°.

Atmosphere—Cloudy to clear.

Total number of birds seen from 8:00 P. M. to 9:15 P. M.—0.

No birds seen for the entire evening.

MADISON, WIS., Apr. 18, 1900.

METEOROLOGICAL DATA.

Wind—Northwest to southeast, velocity 4.

Temperature—46. 8°.

Atmosphere—Cloudy to clear.

Total number of birds observed from 11:15 P.M. to 1:15 A.
M.—121.

11:15 to 11:30—in 3.9—out 8.1.

in 4.5—out 7.7.

in 4.0—out 8.3.

in 4.0—out 8.2—Size 2.

in 3.6—out 8.7—Curved up.

in 3.8—out 8.4—Curved up.

in 3.9—out 1.3.

in 3.5—out 8.6.

in 3.1—out 8.8

in 3.7—out 8.9—All the above birds are about
the size of a robin.

in 4.7—out 8.6—Swift.

in 4.2—out 8.1—Curved down.

in 4.3—out 7.8.

in 3.1—out 2.3.

in 0.0—out 0.0—About one minute with no
birds.

in 3.4—out 1.1.

in 4.9—out 6.9—Out of focus.

in 3.1—out 8.9.

in 0.0—out 0.0—Direction missed.

in 2.5—out 1.8.

in 4.3—out 8.3—Size 1.

in 3.4—out 1.2—Very slow.

in 3.6—out 8.2.

in 3.7—out 7.9—Followed preceding very
closely.

in 3.9—out 7.9.

in 3.2—out 8.9.

in 3.2—out 1.3—Curved up.

in 3.8—out 8.2—Swift—Size 3—Fast flyer and
of large size.

in 3.8—out 1.7.

in 3.8—out 8.9—Slow.

in 3.6—out 8.5.

	in 4.1—out 7.9—Slow—Size 1—Wing-strokes plain.
	in 0.0—out 0.0—No birds for 2 minutes.
	in 4.1—out 8.8.
	in 4.3—out 7.8—Total 33.
11:30 to 11:45—	in 4.8—out 8.2.
	in 4.1—out 2.1—Swift—Out of focus.
	in 4.2—out 7.8.
	in 4.0—out 8.0.
	in 3.1—out 1.8 } These two passed close to one another.
	in 3.5—out 8.1 }
	in 5.8—out 1.1.
	in 5.1—out 8.9.
	in 0.0—out 0.0—Missed direction.
	in 2.6—out 1.2 }
	in 3.3—out 8.1 }
	in 4.8—out 8.3 }
	in 3.2—out 2.6 }
	in 4.0—out 8.0—Dove through the field.
	in 3.5—out 8.9.
	in 3.3—out 2.1.
	in 2.1—out 1.2.
	in 4.0—out 7.4.
	in 5.0—out 6.9.
	in 5.0—out 7.2.
	in 4.3—out 8.2.
	in 4.9—out 7.7.
	in 3.3—out 1.0.
	in 3.6—out 8.2.
	in 4.0—out 7.1.
	in 0.0—out 0.0—No birds for 2 minutes.
	in 3.4—out 8.6.
	in 3.7—out 8.2—Total 27.
11:45 to 12:00—	in 4.2—out 7.5—Fast.
	in 0.0—out 0.0—No birds for 2 1-2 minutes.
	in 4.2—out 7.4.
	in 3.8—out 7.8.
	in 4.0—out 7.1—Swift—Size 3—|—.
	in 4.0—out 6.5—Same species as preceding.
	in 3.2—out 7.2.
	in 4.2—out 6.8—Swift—Size 3—|—.
	in 3.8—out 7.2.

	in 4.2—out 6.0.	
	in 4.5—out 6.8.	
	in 2.8—out 7.8	} Same species.
	in 3.2—out 7.5	
	in 2.0—out 8.1.	
	in 4.2—out 7.5.	
	in 3.0—out 7.3.	
	in 2.0—out 1.2.	
	in 4.5—out 6.5—Very slow—Total 17.	
12:00 to 12:15—	in 3.2—out 7.8.	
	in 4.1—out 7.2.	
	in 4.2—out 8.0.	
	in 4.0—out 7.6.	
	in 4.0—out 7.6—Size 3-|-.	
	in 4.2—out 8.0	} Slow—Flight like goldfinch.
	in 4.5—out 6.5	
	in 4.2—out 8.1	
	in 6.0—out 7.5	
	in 3.7—out 7.8—Swift—Size 3-|-.	
	in 4.0—out 8.0	} In field at same time.
	in 5.0—out 6.2	
	in 3.1—out 8.7	
	in 4.0—out 8.0—Size 3-|-.	
	in 3.2—out 8.7	} Flight like goldfinch.
	in 4.8—out 7.2.	
	in 3.0—out 8.2—Total 17.	
12:15 to 12:30—	in 3.5—out 8.9—Swift.	
	in 3.8—out 8.2.	
	in 3.0—out 8.9—Size 3-|-.	
	in 5.7—out 7.9.	
	in 4.2—out 7.9.	
	in 0.0—out 0.0—No birds for 5 minutes.	
	in 3.8—out 8.3—Slow—Size 1—.	
	in 4.9—out 7.2—Fast—Size 3. Out of focus.	
	in 5.8—out 7.1—Flight like goldfinch.	
	in 5.0—out 2.1—Curved below center.	
	in 4.2—out 8.2.	
	in 5.0—out 1.2.	
	in 7.9—out 4.2—Sailed, like a meadowlark.	
	in 4.0—out 8.6—Swift—Size 1.	
	in 3.9—out 8.5—Slow—Size 1—Flitting care-	
	lessly criss-cross through	
	field. He paused a second	

as if to turn in his course.

Total 14.

12:30 to 12:45—in 4.8—out 7.2—Swift—Size 2—|-.
 in 7.8—out 3.0—Slow—Looked like duck.
 in 3.0—out 7.0.
 in 5.0—out 7.2—Seemed to appear suddenly
 near center of field.
 in 4.5—out 8.5—Size 3.
 in 2.0—out 8.8—Total 6.
 12:45 to 1:00—in 2.0—out 8.8—Total 1.
 1:00 to 1:15—in 4.6—out 7.9—Out of focus.
 in 3.4—out 1.9—Swift—Out of focus.
 in 3.1—out 8.9—Out of focus—Sailing.
 in 5.6—out 7.2—Fast—Out of focus.
 in 2.9—out 0.0—Slow.
 in 3.2—out 8.5—Slow, wing-strokes visible—
 Out of focus.
 in 3.3—out 1.9—Slow, wing-strokes visible—
 Out of focus—Total 7.

MADISON, WIS., May 9, 1900.

METEOROLOGICAL DATA.

Wind—South to southwest, velocity 8.

Temperature—53. 9°.

Atmosphere—Clear.

Total number of birds observed from 7:50 P. M. to 11:45 P. M.—47.

7:50 to 8:00—in 0.0—out 0.0—Total 0.

8:00 to 8:15—in 5.8—out 3.8—Out of focus.

 in 5.1—out 1.6—Slightly blurred—Total, 2.

8:15 to 8:30—in 0.0—out 0.0—Total 0.

8:30 to 8:45—in 8.9—out 5.3—Slow—Size 2—Wing-strokes
 seen—Total 1.

8:45 to 9:00—in 5.0—out 7.0—Fast—Out of focus, obscured
 over 60 per cent of field.

 in 4.8—out 7.1—Size 1—|-. Slightly blurred—
 Total 2.

9:00 to 9:15—in 4.1—out 7.7—Fast. Out of focus. Strokes
 visible.

 in 2.2—out 3.6.—1—|-. Very distinct. Total 2.

9:15 to 9:30—in 8.4—out 7.3—Size 1. Wing-strokes visible.

 in 3.3—out 1.2.—Swift. Size 2—Out of focus.
 Total 2.

- 9:30 to 9:45—in 8.6—out 6.5.—Size 1-|-.
 in 1.2—out 7.3.—Size 3. Slow strokes, little blurred.
 in 4.2—out 7.1.—Same species as first bird of 9:00 to 9:15 period. Total 3.
- 9:45 to 10:00—in .2.2—out 1.5.—Swift. Size 1-|-.
 in 1.7—out 3.4.—Size 1—. Wind rising at 9:50. Total 2.
- 10:00 to 10:15—in 2.0—out 4.2.—Slow. Size 2-|- Wing-strokes visible.
 in 3.7—out 8.5.—Size 2-|- Slightly out of focus. Total 2.
- 10:15 to 10:30—in 4.1—out 2.5.—Fast. Size 1. Total 1.
- 10:30 to 10:45—in 2.6—out 7.7.—Fast. Size 2—. Wing-strokes visible.
 in 2.9—out 3.5.—Flock of 5 ducks parallel to 2.9 to 3.5.
 in 4.4—out 7.1.—Size 2-|- Wing strokes fast.
 in 2.6—out 4.9.—Slow. Size 2-|- Wing-strokes fast.
 in 2.8—out 4.9.—Slow. Size 2-|- Wing-strokes slow, sailing. Same species. Total 10.
- 10:45 to 11:00—in 2.0—out 6.2.—Size 2.
 in 3.0—out 6.0.—Size 3. Out of focus.
 in 1.3—out 7.4.—Size 2. Wing-strokes plain. Total 3.
- 11:00 to 11:15—in 2.2—out 5.9.—Size 1—. Sailed through field.
 in 1.2—out 5.6.—Much out of focus.
 in 5.0—out 7.0.—Size 1—.
 in 1.9—out 6.2.—Size 2. Looked like blackbird.
 in 2.5—out 4.7.—Size 2. Looked like blackbird.
 in 3.2—out 5.5.—Size 3. Duck. Total 6.
- 11:15 to 11:30—in 4.8—out 6.8.—Size 3. Out of focus.
 in 3.4—out 6.5.—Fast. Size 1-|- } Same
 in 2.0—out 5.9.—Fast. Size 1-|- } species.
 in 1.2—out 5.7.
 in 2.3—out 4.8.
 in 4.8—out 7.1.—Out of focus.
 in 2.1—out 5.1.—Size 2. } Same species.
 in 2.2—out 4.8.—Size 2. }
 in 3.8—out 8.0.—Last one out of focus. Total 9.

11:30 to 11:45—in 3.4—out 6.7.—Large wings; flight like bat.
 in 2.8—out 6.4.—Tiny wing-strokes; body
 large. Total 2.

MADISON, Wis., May 10, 1900.

METEOROLOGICAL DATA.

Wind—South; velocity 12.

Temperature—58. 9°.

Atmosphere—Cloudy.

Total number of birds observed from 8:00 P. M. to 9:00 P. M.—4.

8:00 to 8:15—in 5.7—out 7.7.—Swift. Size 2.
 in 3.2—out 8.9.—Swift. Size 1-|- . Total 2.

8:15 to 8:30—in 1.3—out 6.8.—Size 2. Out of focus; very
 close.

 in 3.7—out 8.8.—Size 2. Same as preceding in
 good focus. Total 2.

8:30 to 8:45— Cloudy part of time. None.

8:45 to 9:00— Cloudy most of time. None.
 Stopped observations on ac-
 count of clouds.

MADISON, Wis., May 13, 1900.

METEROLOGICAL DATA.

Wind—South to South Southwest; velocity 14.

Temperature—74. 9°.

Atmosphere—Clear.

Total number of birds observed from 8:50 P. M. to 1:00 A. M.—96.

8:50 to 9:00—in 4.1—out 8.1—Size 1-|- .
 in 3.9—out 8.3—Size 1— .
 in 4.5—out 7.1—Swift—Indistinct.
 in 4.1—out 8.1—Size 1—Somewhat blurred.
 in 5.0—out 7.1—Size 1-|- .
 in 3.0—out 1.9.
 in 3.1—out 1.4—Swift—Like a shot.
 in 4.5—out 6.8—Size 1-|- .
 in 4.5—out 7.4—Indistinct—Total 9.

9:00 to 9:15—in 5.0—out 6.6—Size 3.
 in 3.0—out 8.9—Size 2—Out of focus.
 in 2.3—out 8.8—Size 2-|- . Out of focus.
 in 2.8—out 8.8—Size 2-|- . Out of focus.

- in 3.2—out 8.8—Size 2.
 in 4.2—out 7.6—Size 1-|-.
 in 4.0—out 7.3—Size 2-|- Blurred.
 in 3.2—out 8.3—Size 2-|- Blurred.
 in 4.1—out 7.4—Size 2-|- Slightly blurred.
 in 4.3—out 7.4—Size 3—Out of focus—Total
 10.
 9:15 to 9:30—in 4.5—out 8.0—Size 2—Slightly out of focus.
 in 3.1—out 8.1—Size 1.
 in 3.5—out 8.2—Size 2—Slightly out of focus.
 in 4.0—out 8.2—Size 2.
 in 4.0—out 7.5—Swift—Size 1—Like a shot.
 in 3.5—out 8.4—Size 2.
 in 4.1—out 8.6—Size 1—Indistinct—Total 7.
 9:30 to 9:45—in 1.9—out 7.3—Size 2-|- Indistinct.
 in 2.6—out 1.4—Size 2.
 in 4.9—out 6.8—Size 1-|-.
 in 2.6—out 7.6—Size 2—Somewhat out of
 focus.
 in 4.0—out 8.1—Very fast—Size 1-|- Somewhat out of focus.
 in 3.8—out 8.4—Size 2—Blurred.
 in 5.3—out 6.7—Blurred.
 in 5.2—out 7.1—Size 2.
 in 4.1—out 7.4—Size 1-|- } Same species.
 in 2.8—out 8.7—Size 1-|- }
 Total 10.
 9:45 to 10:00—in 4.1—out 7.2—Size 1-|-.
 in 2.7—out 1.0—Size 1-|-.
 in 4.4—out 6.7—Size 1-|-.
 in 2.8—out 8.9—Size 1—Total 4.
 10:00 to 10:15—in 3.5—out 8.6—Size 3—Very distant.
 in 8.5—out 8.0—Size 2-|-.
 in 3.1—out 8.4—Size 2.
 in 4.2—out 6.3—Size 2—Total 4.
 10:15 to 10:30—in 1.7—out 8.8—Size 1-|-.
 in 4.7—out 5.3—Size 1-|-.
 in 3.1—out 7.1—Size 2-|- Wing-strokes seen,
 somewhat blurred.
 in 3.3—out 8.4—Size 2—Total 4.
 10:30 to 10:45—in 4.2—out 8.3—Size 1.
 in 2.4—out 8.3—Size 1-|-.
 in 2.7—out 6.3—Size 2.

- in 1.6—out 8.2—Size 2—|-. Very distinct.
 in 4.2—out 8.3—Slow—Size 2—Wing-strokes
 slow.
 in 3.1—out 7.2—Size 2 }
 in 3.3—out 8.1—Size 2 } Same species Total 7.
 10:45 to 11:00—in 3.4—out 7.4—Size 1—|-.
 in 3.9—out 8.0—Size 2—Out of focus.
 in 3.3—out 8.2—Curved below center.
 in 2.2—out 7.1.
 in 3.9—out 8.7—Size 1—|-. Wing-strokes plain.
 Total 5.
 11:00 to 11:15—in 3.3—out 1.2—Size 1—Indistinct.
 in 2.3—out 6.4—Size 2—|-. }
 in 2.7—out 6.3—Size 2—|-. } Same species.
 in 3.6—out 5.2—Size 2 }
 in 2.6—out 6.4—Size 2 } Same species.
 in 3.1—out 8.8—Size 1—|-. Indistinct.
 in 4.0—out 8.3—Fast—Size 1.
 in 2.8—out 7.2—Size 3.
 in 2.4—out 7.1—Size 3.
 in 1.1—out 7.8—Size 3—Curved around center.
 in 3.7—out 6.8—Size 1—|-. Indistinct.
 in 2.8—out 8.9—Size 1—Indistinct.
 in 2.6—out 8.3—Swift—Size 1—Flew like a
 shot.
 in 3.4—out 7.8—Swift—Size 2—Total 14.
 11:15 to 11:30—in 1.5—out 7.2—Size 1—|-.
 in 2.8—out 7.2—Size 2—|-.
 in 3.2—out 8.9—Size 2.
 in 4.8—out 7.7—Total 4.
 11:30 to 11:45—in 0.0—out 0.0—Reversed telescope.
 11:45 to 12:00—in 2.7—out 7.3—Size 2.
 in 4.2—out 5.4—Size 2.
 in 3.5—out 7.4—Size 1—|-. Indistinct.
 in 4.4—out 6.5—Size 1—|-.
 in 2.8—out 5.3—Size 1—|-.
 in 8.9—out 6.7—Size 2—Indistinct—Total 6.
 12:00 to 12:15—in 2.9—out 3.9—Size 2.
 in 3.2—out 5.6—Size 2.
 in 2.3—out 4.9—Size 2—Out of focus.
 in 2.1—out 5.8—Size 3—Blurred, wind strong,
 southwest—Total 4.

12:15 to 12:30	in 2.2—out 6.3—Size 1.
	in 2.1—out 7.2—Size 2.
	in 2.0—out 6.0—Size 2.
	in 2.5—out 5.2—Size 2—Total 4.
12:30 to 12:45	in 4.2—out 6.9—Size 2—Slightly blurred.
	in 3.2—out 7.3—Size 1—Total 2.
12:45 to 1:00	in 2.0—out 5.3—Size 2.
	in 1.6—out 5.3—Size 2—Total 2.

MADISON, Wis., Oct. 8, 1900.

METEOROLOGICAL DATA.

Wind—Northwest to north northwest.

Temperature—47. 5°.

Atmosphere—Clear.

Total number of birds observed from 8:00 P. M. to 9:45 P. M.—35.

8:00 to 8:15	in 1.2—out 5.3—Size 2.
	in 3.0—out 7.0—Size 3—Crow(?).
	in 8.6—out 4.0.
	in 7.8—out 5.0.
	in 8.2—out 4.0.
	in 8.5—out 3.0.
	in 2.7—out 4.8.
	in 7.0—out 3.2—Sailing with the wind—Total, 8.
	8:15 to 8:30—in 8.8—out 3.0.
	in 7.0—out 4.0.
8:30 to 8:45	in 7.8—out 4.3—Size 3—Long tail.
	in 8.0—out 3.8—Out of focus.
	in 7.2—out 4.0.
	in 1.0—out 4.0.
	in 7.0—out 3.0.
	in 7.5—out 4.0.
	in 1.5—out 2.7—Total 9.
	8:45 to 9:00—in 0.0—out 0.0—No observations made.
8:45 to 9:00	in 8.0—out 3.6.
	in 7.0—out 2.2.
	in 6.2—out 1.8.
	in 8.5—out 1.8.
	in 7.0—out 3.3.
	in 6.5—out 5.0.
	in 6.5—out 4.5—Total 7.

9:00 to 9:15—in	8.2—out	2.6.
	in 7.0—out	3.0.
	in 7.5—out	3.0.
	in 7.0—out	3.0.
	in 1.0—out	5.0.
	in 8.2—out	4.0—Total 6.
9:30 to 9:45—in	8.5—out	2.4.
	in 7.5—out	4.0.
	in 6.5—out	3.5.
	in 6.5—out	2.7.
	in 6.0—out	5.0—Total 5.

MADISON, WIS., Apr. 27, 1901.

METEOROLOGICAL DATA.

Wind—South.

Temperature—62. 8°.

Atmosphere—Clear.

Total number of birds observed from 9:45 P. M. to 11:00 P. M.—6.

9:45 to 10:00—in	0.0—out	0.0—Total 0.
10:00 to 10:15—in	3.8—out	6.7—Total 1.
10:15 to 10:30—in	0.0—out	0.0—Total 0.
10:30 to 10:45—in	0.0—out	0.0—Total 0.
10:45 to 11:00—in	2.3—out	5.7—Fast—Size 1.
	in 2.7—out	6.0—Size 1—Total 3.
	in 2.0—out	5.5—Fast—Size 1—Total 3.
11:00 to 11:15—in	1.9—out	6.2.
	in 2.4—out	6.3—Size 3—Total 2.

MADISON, WIS., May 1, 1901.

METEOROLOGICAL DATA.

Wind—Southwest.

Temperature—72. 4°.

Atmosphere—Clear.

Total number of birds observed from 10:00 P. M. to 11:15 P. M.—3.

10:00 to 10:15—in	7.4—out	4.8—Total 1.
10:15 to 10:30—in	0.0—out	0.0—No observations made.
10:30 to 10:45—in	5.9—out	1.9—Out of focus—Total 1.
10:45 to 11:00—in	7.9—out	3.5—Total 1.
11:00 to 11:15—in	0.0—out	0.0—Total 0.

BELOIT, WIS., May 11, 1900.

METEOROLOGICAL DATA—(Taken same as for Madison).

Wind—South to southwest, velocity 10.

Temperature—69. 5°.

Atmosphere—Partly cloudy toward morning.

Total number of birds observed from 8:00 P. M. to 2:00

A. M.—134.

8:00 to 8:15—in 4.8—out 8.7.

in 2.5—out 8.0—Swift—Size 2—.

in 2.8—out 1.1—Size 1—|—.

in 3.0—out 7.6—Size 2.

in 5.2—out 7.1—Very Swift—Size 1—Total 6.

8:15 to 8:30—in 4.0—out 7.3—Very swift—Size 1.

in 4.8—out 5.5—Size 3—|—.—Out of focus.

in 4.0—out 5.8.

in 2.0—out 8.0

in 2.0—out 8.0 } Following each other closely.

in 3.0—out 7.5—Slow—Size 1.

in 3.0—out 7.0.

in 2.5—out 8.3.

in 5.0—out 5.7—Slow—Size 3—Seemed very close.

in 3.1—out 7.6—Slow—Size 2.

in 3.8—out 7.2—Size 1—Very distant.

in 1.0—out 5.5—Out of focus.

in 2.5—out 8.2—Size 2—Total 13.

8:30 to 8:45—in 2.0—out 8.0—Size 1—Total 1.

8:45 to 9:00—in 0.0—out 0.0—Total 0.

9:00 to 9:15—in 0.0—out 0.0—No observations made.

9:15 to 9:30—in 0.0—out 0.0—No observations made.

9:30 to 9:45—in 3.7—out 8.2—Size 2—Slightly out of focus.

in 4.2—out 6.8—Size 2—.

in 4.2—out 5.9—Size 3.

in 4.0—out 7.8—Very swift—Size 1—Total 4.

9:45 to 10:00—in 2.2—out 7.6—Size 2.

in 4.2—out 7.6.

in 2.0—out 6.0—Size 3—Total 2.

10:00 to 10:15—in 3.9—out 6.6—Size 2.

in 8.3—out 5.2—Out of focus.

in 3.3—out 5.8—Swift—Size 2— } In field at

in 3.3—out 5.8—Swift—Size 2— } same time.

in 4.3—out 8.7—Swift—Size 2— Total 5.

- 10:15 to 10:30—in 2.3—out 5.3—Swift—Size 1.
 in 2.2—out 6.3—Swift—Size 1.
 in 5.0—out 7.0—Swift—Size 1.
 in 2.3—out 8.2—Wing-strokes visible, looked
 as if flying sidewise.
 in 4.2—out 6.0.
 in 8.9—out 7.0—Out of focus.
 in 3.7—out 6.0—Size 1—. Very tiny, curved
 over center.
 in 2.2—out 5.8—Very slow—Size 3—Total 8.
- 10:30 to 10:45—in 3.7—out 6.8—Size 1—Flight like goldfinch.
 in 8.0—out 7.2—Size 3.
 in 2.2—out 4.8—Swift—Size 1—. Very tiny
 —Total 3.
- 10:45 to 11:00—in 2.0—out 7.5—Swift—Size 2-|-.
 in 2.2—out 5.3—Out of focus.
 in 3.1—out 6.2—Size 2-|-. Wing-strokes visible.
 in 2.2—out 6.9—Size 1.
 in 2.5—out 5.8—Swift—Total 5.
- 11:00 to 11:15—in 1.2—out 8.2.
 in 1.0—out 7.1—Size 2-|-. Curved.
 in 2.7—out 7.2.
 in 8.9—out 5.7—Very swift—Size 1—. Tiny.
 in 2.2—out 6.8.
 in 2.7—out 5.7—Swift—Size 2-|-. Total 6.
- 11:15 to 11:30—in 1.5—out 5.2—Slow—Out of focus.
 in 2.1—out 6.8—Size 3—. Wing-strokes visible.
 in 2.1—out 5.6—Size 2.
 in 1.3—out 7.1—Total 4.
- 11:30 to 11:45—in 2.4—out 5.3.
 in 3.0—out 6.4—Total 2.
- 11:45 to 12:00—in 2.2—out 8.5—Size 3-|-. Gull(?), large, slender
 wings and square tail.
 in 3.2—out 4.8—Size 2.
 in 1.8—out 5.2—Swift—Total 3.
- 12:00 to 12:15—in 2.7—out 4.3—Size 3.
 in 1.7—out 6.0—Out of focus.
 in 3.8—out 4.2—Size 3—Curved.
 in 1.6—out 6.8—Size 2.
 in 8.5—out 5.8—Out of focus—Total 5.
- 12:15 to 12:30—in 0.0—out 0.0—No observations made.
- 12:30 to 12:45—in 8.8—out 7.2—Slightly out of focus.
 in 2.8—out 6.0—Same species as preceding.

		in 8.2—out 6.3—Soaring—Out of focus—Total 3.	
12:45 to	1:00—	in 0.0—out 0.0—No observations made.	
1:00 to	1:15—	in 2.8—out 6.8—Swift—Size 2.	
		in 1.8—out 5.8 } 2 birds parallel to 1.8, 5.8 in	
		in 1.8—out 5.8 } field at same time.	
		in 2.8—out 5.8—Swift—Same as preceding—	
		Out of focus.	
		in 2.3—out 5.4—Slow—Size 2.	
		in 3.0—out 5.2—Swift }	Same species.
		in 1.0—out 5.0—Swift }	
		in 1.0—out 5.8—Out of focus.	
		in 1.0—out 5.8.	
		in 1.3—out 2.8—Wing-strokes visible.	
		in 1.8—out 3.8.	
		in 1.0—out 7.2—Curved.	
		in 1.8—out 4.2—Flight like goldfinch.	
		in 2.8—out 6.0—Slow.	
		in 2.8—out 3.8—Slow—Total 15.	
1:15 to	1:30—	in 2.0—out 3.4—Swift.	
		in 1.0—out 7.2—Slow—Flight like goldfinch.	
		in 1.0—out 5.0—Size 2—Can hear many birds	
		calling, as if circling over-	
		head. Since 1:00 o'clock	
		the birds seem to have been	
		coming in bunches.	
		in 2.2—out 3.2—Curved.	
		in 3.2—out 7.2—Curved.	
		in 8.8—out 5.8—Slow—Flight like goldfinch.	
		in 2.8—out 4.0.	
		in 2.3—out 5.8—Slow.	
		in 1.3—out 6.3—Swift.	
		in 1.3—out 6.8—Swift.	
		in 2.3—out 0.0—Very swift.	
		in 8.7—out 6.6—Total 12.	
1:30 to	1:45—	in 8.6—out 5.8—Swift—Size 1—|-. }	In field at
		in 2.0—out 5.8—Swift—Size 1—|-. }	
		in 2.0—out 5.8—Swift—Size 1—|-. }	
		in 1.0—out 7.0—Size 1—|-. }	Succeeding each
		in 1.8—out 5.5—Size 1—|-. }	
		in 5.8—out 6.1—Size 1—|-. }	
		in 1.0—out 6.0—Out of focus.	other very rap-
		in 2.8—out 5.0—Swift—Size 1—	idly.

	in 2.8—out 4.6—Slow—Curved.	
	in 1.0—out 5.8—Swift—Size 1—.	
	in 8.3—out 7.0—Swift—Size 2—.	
	in 2.0—out 4.6—Flight like goldfinch.	
	in 2.0—out 5.8—Same as preceding one.	
	in 6.0—out 7.8.	
	in 8.7—out 6.8.	
	in 1.5—out 5.2—Size 1—. Very tiny.	
	in 1.1—out 5.5.	
	in 8.3—out 6.7—Out of focus.	
	in 1.6—out 5.8—Out of focus.	
	in 1.6—out 6.6—Out of focus.	
	in 1.0—out 5.2—Slow—Total 21.	
1:45 to 2:00—	in 8.4—out 7.8.	
	in 1.8—out 0.0	} Same species.
	in 1.0—out 5.6	
	in 2.8—out 4.6.	
	in 2.0—out 4.6.	
	in 2.7—out 4.0—Swift.	
	in 3.5—out 2.0.	
	in 8.2—out 6.9—Size 2.	
	in 1.0—out 5.3.	
	in 8.3—out 6.0—Swift—Size 1—|.	
	in 2.8—out 4.3.	
	in 5.0—out 8.0—Slow—Size 3.	
	in 1.8—out 5.2.	
	in 2.2—out 4.8	} Swift—Succeeding each other closely.
	in ...—out ...	
	in ...—out ...	} In field at same time.
	Clouds at 1:45 obscured the moon; moon low in southwest—Total 16.	

BELOIT, WIS., May 12, 1900.

METEOROLOGICAL DATA.

Wind—Southwest, velocity 12.

Temperature—70. 8°.

Atmosphere—Clear.

Total number of birds observed from 8:00 P. M. to 3:25 A. M.—363.

8:00 to 8:15—in 3.1—out 8.5.

in 3.7—out 7.9.

		in 2.5—out 8.5.
		in 4.5—out 6.4—Swift.
		in 3.0—out 7.6—Slow.
		in 3.2—out 7.5.
		in 3.5—out 8.1—Distant.
		in 4.5—out 5.6—Size 3—Out of focus.
		in 4.5—out 6.8—Size 3—Total 9.
8:15 to 8:30	—	in 0.0—out 0.0—No observations made.
8:30 to 8:45	—	in 3.8—out 6.6—Swift—Size 2—.
		in 3.0—out 6.1—Size 2—|. Out of focus.
		in 3.0—out 6.0—Size 2—|. Out of focus.
		in 3.8—out 7.7—Size 1—Flight like goldfinch.
		in 3.8—out 1.2—Slow—Distant—Total 5.
8:45 to 9:00	—	in 4.0—out 6.5—Slow—Distant.
		in 3.8—out 6.4—Swift—Out of focus.
		in 3.0—out 8.6—Slow.
		in 3.2—out 7.5—Very fast—Size 1.
		in 3.2—out 8.8—Slow—Size 3—Total 5.
9:00 to 9:15	—	in 3.2—out 8.1—Slow—Size 3—Large wings.
		in 2.8—out 8.3.
		in 3.0—out 7.2—Size 1—Very small.
		in 3.2—out 7.8—Swift—Size 1—Out of focus.
		in 3.8—out 8.8—Curved up.
		in 3.2—out 7.5—Size 2—Total 6.
9:15 to 9:30	—	in 3.5—out 6.3—Swift—Size 2 } Same species.
		in 3.2—out 6.0—Swift—Size 2 }
		in 3.8—out 6.2—Size 2—|. }
		in 3.2—out 7.2—Swift—Size 1—.
		in 3.7—out 6.2—Very distant.
		in 2.4—out 1.6—Total 6.
9:30 to 9:45	—	in 3.3—out 5.7.
		in 3.0—out 7.0.
		in 3.4—out 7.6—Total 3.
9:45 to 10:00	—	in 0.0—out 0.0—No birds for 2 or 3 minutes.
		in 3.0—out 5.0—Swift—Size 1—.
		in 8.9—out 6.8—Swift—Size 3.
		in 1.0—out 6.0—Size 1—.
		in 1.2—out 6.0—Size 1—.
		in 7.0—out 3.0—Curved around center.
		in 1.7—out 4.2—Out of focus.
		in 1.6—out 4.0 }
		in 8.9—out 6.0 }
		in 1.0—out 4.5—Out of focus.

in 8.0—out 5.2—Out of focus.

in 2.0—out 5.0—Size 1—|. The only bird in the
last five minutes—
Total 11.

10:00 to 10:15—in 8.9—out 5.7.

in 8.0—out 7.0—Slow—Size 1.

in 1.0—out 5.0—Size 1.

in 1.0—out 5.0

Pause.

in 1.0—out 5.0

in 1.0—out 5.0.

in 7.0—out 5.0—Out of focus.

in 7.5—out 4.0.

in 1.0—out 4.7—Slow—Size 3.

in 0.0—out 0.0—Short pause of no birds.

in 2.0—out 3.6

in 1.3—out 2.4

in 1.0—out 3.0

in 0.0—out 0.0—No observations taken.

10:45 to 11:00—in 3.0—out 7.0—Size 3.

in 3.5—out 6.0—Size 3—Same as preceding.

in 3.0—out 4.8—Swift—Size 2—A snipe is
calling.

in 1.7—out 6.3—Swift—Size 2.

in 1.5—out 8.5.

in 3.7—out 6.4—Swift—Size 2—Curved.

in 8.2—out 7.1—Size 3.

in 2.0—out 8.0.

in 3.0—out 6.2—Swift—Size 1.

in 2.0—out 8.0.

in 1.5—out 5.9—Out of focus, curved—Total
11.

11:00 to 11:15—in 3.0—out 5.7—Size 2.

in 1.6—out 5.6—Swift—Size 2—.

in 1.0—out 7.8.

in 1.8—out 6.7—Size 2—Total 4.

11:15 to 11:30—in 4.8—out 5.5.

in 8.6—out 5.8.

in 1.0—out 7.0—Size 2—|—.

in 2.0—out 6.0—Size 2—|—.

in 2.0—out 8.2—Curved across edge of field.

in 3.8—out 6.2.

in 2.0—out 7.0—Curved through center.

- in 2.0—out 6.0—Swift—Size 1—Out of focus
 in 2.0—out 8.0—Size 2.
 in 8.2—out 7.0—Swift—Size 2—.
 in 2.2—out 6.1—Slow—Size 3—Looked like a
 gallinaceous bird—Total 11.
- 11:30 to 11:45—in 0.0—out 0.0—No observations taken.
- 11:45 to 12:00—in 1.7—out 8.2—Slow—Size 3—Distant, wing-
 strokes plain.
 in 1.0—out 5.2—Slow—Size 3—Wing-strokes
 plain.
 in 2.0—out 8.0.
 in 8.5—out 7.0.
 in 2.0—out 6.0—Size 3—Wind turning south-
 east. Total 5.
- 12:00 to 12:15—in 2.0—out 6.0—Swift—Size 1. }
 in 2.0—out 6.0—Swift—Size 1. }
 in 1.8—out 5.0—Swift—Size 1. }
 in 1.8—out 5.0—Swift—Size 1. }
- Across the field in almost the same time. Same species. }
 in 1.8—out 6.3.
 in 2.2—out 5.8.
 in 2.2—out 4.9—Total 7.
- 12:15 to 12:30—in 3.2—out 4.2.
 in 1.0—out 5.5—Swift—Size 2.
 in 2.5—out 4.0—Out of focus—5 minutes used
 to reverse telescope; snipe
 calling—Total 3.
- 12:30 to 12:45—in 2.0—out 4.7.
 in 4.0—out 5.8—Slow—Distant.
 in 1.7—out 5.8.
 in 2.0—out 8.0—Size 1—. Curved.
 in 2.7—out 5.8.
 in 1.5—out 6.4.
 in 2.2—out 4.9.
 in 1.6—out 5.8—Swift—Size 1—|-.
 in 3.0—out 5.1—Total 9.
- 12:45 to 1:00—in 8.5—out 6.5.
 in 4.0—out 2.0—Out of focus.
 in 1.0—out 3.0—Out of focus, curved.
 in 2.0—out 6.8.
 in 1.8—out 4.8—Swift.
 in 2.6—out 5.3.
 in 8.5—out 5.8.

[illegible]

	—	—	bunches, several in the field
	—	—	at same time. Came too
	—	—	fast to note exact direction.
	in 1.8—out	5.8.—Size 2—.	
	in 2.0—out	5.8.	
	in 3.0—out	8.3.—Size 1—.	
	in 1.2—out	6.3.—Size 2—.	
	in 2.1—out	4.3.—Slow. Size 2.	
	in 1.2—out	6.0.—Size 1.	
	in 1.8—out	5.8.—Size 2.	
	in 3.0—out	6.3.—Swift.	
	in 2.8—out	5.8.—Size 2.	
	in 1.6—out	5.8.—Size 2. Total 35.	
2:00 to 2:15—	in 1.7—out	5.8.—Swift. Size 1.	
	in 2.0—out	7.0.—Size 2. Seen edgewise.	
	in 8.2—out	5.9.—This and preceding in field at	
	in 2.0—out	5.0. same time.	
	in 2.0—out	5.0.	
	in 1.0—out	6.0.	
	in 8.8—out	6.0.	
	in 1.5—out	5.2.	
	in 1.2—out	6.4.—Succeeding each other rapidly.	
	in 3.0—out	4.4.	
	in 4.2—out	6.2.—Probably all same species.	
	in 1.0—out	6.0.—Looked like Icteridae.	
	in 2.0—out	3.7.	
	—	—	
	—	—	
	—	—	
	in 8.6—out	5.9.	
	in 1.7—out	4.9.—Size 2.	
	in 3.0—out	4.5.	
	in 1.2—out	5.5.—Size 2.	
	in 1.8—out	5.7.	
	in 2.2—out	5.7.—Total 22.	
2:15 to 2:30—	in 1.2—out	5.2.	
	in 1.3—out	5.0.—This and preceding same species.	
	in 8.9—out	5.8.	
	in 1.5—out	5.0.	
	in 1.3—out	5.5.	
	in 8.6—out	5.8.	
	in 1.5—out	5.6.—Size 1—.	

- in 8.5—out 6.2.—Flight like goldfinch.
 in 1.0—out 5.2.—Swift. Size 1—.
 in 2.3—out 5.0.
 in 2.5—out 5.0.
 .. in 1.2—out 5.8.—No birds seen for last five
 minutes. Total 12.
- 2:30 to 2:45—in 1.8—out 4.6.
 in 2.0—out 5.6.—Size 1.
 in 1.5—out 5.0.—Size 1. Many lisps are heard.
 in 2.0—out 5.8.
 in 2.5—out 5.2.—Size 1.
 in 2.5—out 5.2.—Size 1. This and preceding
 parallel to 2.5—5.2. In field
 at same time.
- in 2.0—out 5.8.—Slow. Size 1-|-.
 — — Flock. About 10 all parallel
 to about 2.0—5.8.
- in 8.3—out 6.0.—Three more.
 in 2.0—out 4.6.—Many parallel to 2.0—4.6.
 in 1.2—out 5.5.
 in 3.0—out 4.4.—Slightly larger than preceding.
 in 1.8—out 5.0.
 in 1.0—out 5.6.—About 11 parallel to 1.0—5.6.
 in 2.0—out 5.2.
 in 2.0—out 5.2.
 in 2.0—out 5.2.—Fast. Size 1. This and two
 preceding.
- in 2.0—out 5.2.
 in 2.2—out 5.0.
 in 2.2—out 5.0.
 in 2.0—out 5.0.
 in 2.0—out 5.0.
 in 2.0—out 5.0.—Note regularity of direction.
 in 2.5—out 4.3.
 in 2.0—out 5.6.
 in 2.2—out 5.2.
 in 2.0—out 5.0.
 in 1.2—out 5.5.
 in 6.2—out 6.4.
 in 6.2—out 6.4.
 in 2.0—out 4.8.
 in 2.0—out 5.0.—Total 53.

- 2:45 to 3.00—in 2.2—out 4.7.—3 parallel to 2.2—4.7.
 in 1.5—out 5.0.—Same species.
 in 2.1—out 5.0.
 in 8.9—out 6.0.
 in 1.0—out 6.0.
 in 1.5—out 5.2.—3 parallel to 1.5—5.2.
 — — Another and another.
 in 1.0—out 5.8.—4 parallel to 1.0—5.8.
 — — Same species.
 — — 2 more.
 — — Another.
 in 1.5—out 5.3.—5 parallel to 1.5—5.3. All
 these had flight like gold-
 finch and were probably
 same species.
- in 2.0—out 4.5.
 in 2.0—out 4.3.—Many lisps are heard.
 in 2.5—out 5.3.
 in 3.0—out 4.4.
 — — Same as preceding; out of
 focus.
- in 2.5—out 5.2.—2 parallel to 2.5—5.2.
 — — Pause. No birds for over one
 minute.
- in 2.0—out 5.0.—Flight like goldfinch.
 in 1.5—out 5.4.
 in 1.5—out 5.4.
 in 2.0—out 4.7.
 in 2.0—out 4.7.—Coming in regular succession.
 in 2.0—out 5.0.
 in 2.0—out 5.0.—Out of focus.
 — — 2 more not out of focus.
 — — Another.
- in 8.5—out 6.0.
 in 1.0—out 5.7.
 in 1.5—out 5.0.
 in 1.5—out 5.5.—Slightly larger than the pre-
 ceding ones.
- in 1.0—out 5.6.
 in 1.8—out 5.2.
 in 1.8—out 5.2.—This and preceding rapidly
 succeeding each other. To-
 tal 48.

3:00 to 3:15—in 1.9—out 5.3
in 2.0—out 4.8.
in 2.0—out 5.0.—2 birds; flight like goldfinch.
in 1.5—out 5.2.—Same; 3 birds.
in 2.0—out 5.2.—Out of focus.
in 2.0—out 5.5.—Flew toward me. In field a long time.
in 5.0—out 5.8.
in 5.0—out 5.8.—Same as preceding.
— — — Out of focus.
in 1.0—out 6.2.—Out of focus.
in 2.0—out 5.0.—2 birds, flight like goldfinch.
in 1.2—out 6.0.
in 2.2—out 4.9.—2 birds.
in 8.3—out 5.8.
in 1.0—out 5.9.—Very slow.
in 1.0—out 5.9.—4 birds; flight like goldfinch.
in 2.0—out 6.0.—2 birds; flight like goldfinch.
in 8.9—out 6.2.
in 1.0—out 5.0.—Out of focus.
in 1.8—out 5.0.
in 2.0—out 4.7.
in 3.2—out 6.8.—Flew toward me. It grew in size.
in 2.0—out 5.0.
in 8.7—out 6.0.
in 8.5—out 6.0.—Out of focus.
in 1.2—out 5.0.
in 1.8—out 5.2.
in 2.0—out 5.0.—2 birds.
in 5.8—out 1.5.—Size 1. Away out of focus.
in 2.0—out 5.0.—12 more at almost the same time.
— — — 2 more, same direction and 2 farther off.
in 8.3—out 5.2.
— — — Several were succeeding each other rapidly. Total 56-|.

3:15 to 3:30—in 1.8—out 5.0.
in 2.5—out 3.7.
in 1.0—out 5.8.
— — — Pause. Moon obscured by clouds.

in 1.5—out 6.0.

in 1.0—out 5.3.—Size 3.

Total 5. Stopped at 3:25.
Moon low in S. W., dropping behind a bank of clouds.

BELOIT, WIS., May 13, 1900.

METEOROLOGICAL DATA.

Wind—South to southwest, velocity 12.

Temperature—74. 9°.

Atmosphere—Clear.

Total number of birds observed from 8:00 P. M. to 3:45

A. M.—285.

8:00 to 8:15—in 3.0—out 7.4—Slow—Size 2. Long tail.

in 4.0—out 6.7—Size 2—.

in 8.0—out 2.2—Size 1. Out of focus.

in 3.3—out 7.7.

in 3.2—out 7.1—Size 2—. Flight like gold-finch.

in 5.0—out 8.1—Size 1—. Total 6.

8:15 to 8:30—in 3.2—out 7.0—Size 2—.

in 2.9—out 7.2—Size 2-|-.

in 2.8—out 7.2—Size 1—.

in 4.0—out 6.8—Size 2—.

in 8.0—out 2.0—Size 1. Out of focus.

in 2.8—out 7.6—Size 2—.

in 3.8—out 6.7—Size 2-|-.

in 3.0—out 7.5—Size 1—.

in 3.5—out 7.4—Size 2.

in 3.8—out 7.7—Size 2.

in 2.2—out 8.2—Slow—Size 2-|-.

in 3.7—out 7.0—Swift.

in 2.2—out 8.2—Size 2-|-.

focus.

in 8.2—out 3.0—Size 1—Out of focus. Total 14.

8:30 to 8:45—in 3.5—out 7.0.

in 2.0—out 8.5.

in ...—out ...—Missed direction.

in 2.7—out 7.2—Swift—Size 2.

in 3.7—out 6.6—Swift—Size 2-|-.

	in 3.7—out 7.0.
	in 1.2—out 6.3—Size 2—Out of focus.
	in 3.8—out 7.5—Size 1—Total 8.
8:45 to 9:00	—in 3.2—out 7.2—Slow—Size 3.
	in 3.2—out 7.2—Swift—Size 1.
	in 3.8—out 6.6—Size 2—
	in 3.7—out 7.2—Swift.
	in 4.6—out 6.3—Total 5.
9:00 to 9:15	—in 2.8—out 7.0.
	in 3.2—out 7.5—Swift—Size 1.
	in 3.7—out 6.3—Size 2—
	in 4.9—out 6.7.
	in 1.7—out 7.2—Swift.
	in 3.8—out 6.8—Size 2.
	in 2.1—out 7.5.
	in 2.8—out 7.8.
	in 2.6—out 8.4—Total 9.
9:15 to 10:00	—in 0.0—out 0.0—No observations taken.
10:00 to 10:15	—in 3.8—out 6.9—Close, wing-strokes plain.
	in 2.3—out 7.2.
	in 3.7—out 6.7.
	in 3.2—out 6.7—Very swift—Size 2—Looked tiny.
	in 3.5—out 7.2—Very swift—Size 2—Looked tiny.
	in 3.6—out 7.2.
	in 4.0—out 6.2—Out of focus.
	in 3.0—out 7.2.
	in 3.0—out 7.0—Total 9.
10:15 to 10:30	—in 2.3—out 7.3.
	in 5.4—out 7.3.
	in 2.4—out 8.3.
	in 4.0—out 7.0.
	in 3.0—out 1.8.
	in 3.0—out 7.3—Total 6.
10:30 to 10:45	—in 3.0—out 7.6.
	in 1.4—out 7.5—Out of focus.
	in 1.8—out 4.8.
	in 3.6—out 6.3.
	in 2.8—out 8.2.
	in 4.0—out 6.2.
	in 4.0—out 7.1—Total 7.

- 10:45 to 11:00—in 2.8—out 4.8—Slow—Size 2-|-.
- in 3.0—out 7.2.
 - in 2.4—out 7.5.
 - in 3.5—out 6.3.
 - in 1.5—out 5.2.
 - in 8.6—out 7.1—Size 3.
 - in 3.7—out 6.2.
 - in 1.3—out 8.5—Swift—Killdeer calling.
 - in 2.5—out 7.3—This was the only bird during
the last 5 minutes. Total 9.
- 11:00 to 11:15—in 4.0—out 6.0—Swift—Out of focus. Total 1.
- 11:15 to 11:30—in 3.0—out 8.1.
- in 3.8—out 2.4—Size 1—. Curved near center.
 - in 3.2—out 5.3.
 - in 1.2—out 7.2.
 - in 2.4—out 8.0—Total 5.
- 11:30 to 11:45—in 4.2—out 8.1—Size 1—.
- in 2.0—out 8.0—Size 3.
 - in 4.6—out 6.2—Size 3—.
 - in 3.0—out 4.3—Size 3—Close.
 - in 5.2—out 6.8—Curved.
 - in 4.0—out 5.3.
 - in 3.0—out 5.0—Swift—Size 3. Total 7.
- 11:45 to 12:00—in 4.0—out 6.0—Total 1.
- 12:00 to 12:30—in 0.0—out 0.0—No observations taken.
- 12:30 to 12:45—in 2.8—out 6.0—Strong S. W. wind arising.
- in 3.7—out 6.1—Swift—Size 2—
 - in 1.0—out 7.8—Swift—Size 2—
 - in 2.0—out 6.6—Swift—Size 2—
 - in 2.6—out 5.0—Swift—Size 2—
- } Same species.
- in 2.2—out 5.9—2 birds, out of focus.
 - in 8.3—out 7.6—Same as preceding.
 - in 1.8—out 5.8—Total 8.
- 12:45 to 1:00—in 2.0—out 7.1—Slightly out of focus.
- in 1.0—out 5.5—Very distant.
 - in 3.9—out 5.8.
 - in 3.5—out 7.2.
 - in 2.0—out 5.1—Size 2.
 - in 8.8—out 6.4—Out of focus.
 - in 1.3—out 5.3—Total 7.
- 1:00 to 1:15—in 2.0—out 5.7—Size 2-|- 2 birds.
- in 5.0—out 7.2—Slightly out of focus.

		in 1.3—out 5.8—Swift	} Same species.
		in 2.8—out 5.2—Swift	
		in 2.8—out 5.2—Swift	
		in 8.6—out 7.8—Out of focus.	
		in 2.5—out 5.7—Curved below center, circling the edge of the field.	
		in 2.7—out 5.7—Curved over center. Total 9.	
1:15 to 1:30	—in 0.0—out 0.0—No observations taken.		
1:30 to 1:45	—in 4.2—out 1.2.		
	in 1.0—out 5.8—Slightly out of focus.		
	in 2.4—out 6.8—Distant.		
	in 8.3—out 6.8.		
	in 3.0—out 5.9—Out of focus.		
	in 8.2—out 6.0—Out of focus.		
	in 2.0—out 6.0—Close and large. This bird made a complete turn in the field.		
	in 1.0—out 5.8—Total 8.		
1:45 to 2:00	—in 1.0—out 6.8.		
	in 2.3—out 5.8—2 birds, both curved over center.		
	in 8.4—out 7.1—Out of focus.		
	in 8.6—out 7.0.		
	in 3.0—out 4.9.		
	in 1.0—out 6.5—Out of focus, curved.		
	in 3.7—out 5.7.		
	in 1.7—out 5.3—Out of focus. Total 9.		
2:00 to 2:15	—in 0.0—out 0.0—No observations taken.		
2:15 to 2:30	—in 7.0—out 6.0—Out of focus.		
	in 3.5—out 4.2.		
	in 2.3—out 5.6—Size 3—2 birds.		
	in 4.8—out 7.9—Size 1—.		
	in 2.2—out 5.8—Slow—Wing-strokes plain.		
	in 2.0—out 5.2—Swift.		
	in 2.1—out 4.0—Looked as if propelled by wind.		
	in 5.5—out 1.7—Out of focus—Total 9.		
2:30 to 2:45	—in 2.0—out 6.0.		
	in 8.6—out 7.2.		
	in 2.0—out 5.2.		
	in 1.0—out 5.2.		
	in 1.8—out 5.5—Swift.		
	in 1.8—out 5.2—Out of focus.		

- in 2.3—out 5.0.
 in 1.8—out 5.6—Size 2.
 in 1.0—out 7.6.
 in 2.6—out 8.2—Very distant.
 in 1.6—out 5.7—Total 12.
 in 8.5—out 5.9—Out of focus.
- 2:45 to 3:00—in 0.0—out 0.0—No observations taken.
- 3:00 to 3:15—in 2.6—out 5.0.
 in 2.0—out 4.5.
 in 1.6—out 5.5.
 in 2.0—out 4.7.
 in 8.6—out 5.8—2 birds.
 in 1.0—out 7.2—Out of focus.
 in 5.2—out 1.5.
 in 1.0—out 6.3—Over center.
 in 1.5—out 5.3—Flight and call like goldfinch.
 in 8.4—out 6.3—Same as preceding.
 in 5.3—out 8.7—Out of focus.
 in 2.3—out 4.4—Slow.
 in 1.8—out 5.6—4 birds.
 in 2.0—out 5.6—Size 3.
 in 1.2—out 5.7.
 in 3.1—out 4.1—Slow.
 in 1.6—out 5.0—Swift—Size 1.
 in 2.0—out 4.8—Total 22.
- 3:15 to 3:30—in 8.7—out 6.0—2 birds.
 in 8.1—out 6.1—Out of focus.
 in 6.0—out 1.0—Out of focus.
 in 2.1—out 5.5.
 in 3.0—out 4.6—2 birds.
 in 2.0—out 5.8—Flight like goldfinch.
 in 2.2—out 5.5.
 in 2.0—out 6.0—2 birds.
- Another.
- in 2.0—out 6.0—About a dozen parallel to 2—6
 in 2.0—out 6.0—6 more.
 in 6.0—out 8.2—Out of focus.
 in 2.0—out 5.0—Several parallel to 2—5.
 in 3.7—out 2.5—Out of focus. Little groups
 of birds are succeeding
 each other in ever-increasing
 rapidity. Total 33.

3:30 to 3:45—in ...—out ...—Total 81.

The birds were flying in such rapid succession that I could not stop to take the direction. There were 81 birds counted, flying from about 2—5 and 2—6. Of these about 15 were out of focus and flying in promiscuous directions. The moon was being obscured by the trees. The telescope made an angle of about 8° with the horizontal.

LAKE FOREST, Ill., May 11, 1900.

METEOROLOGICAL DATA.

Wind—Moderate; Southwest.

Temperature—Warm.

Atmosphere—Partly cloudy.

Total number of birds observed from 7:45 P. M. to 10:55 P. M.—73.

7:45 to 8:00—in 4.0—out 2.0.—Fast. Size 2.
in 4.0—out 2.0.—Fast. Size 2.
in 4.0—out 2.0.—Fast. Size 2.
in 4.0—out 2.0.—Fast. Size 2. This and all
preceding out of focus.
in 4.0—out 2.0.—Fast. Size 2. Wing-strokes
seen.
in 4.0—out 2.0.—Fast. Size 2.—Out of focus.
Total 6.

8:00 to 8:15—in 4.0—out 2.0.—Fast. Size 2.
in 3.0—out 2.0.—Fast. Size 2.
in 3.0—out 2.0.—Fast. Size 2.
in 4.0—out 1.0.—Fast. Size 2. This and all
preceding out of focus.
Total 4.

8:15 to 8:45 No observations taken.

8:45 to 9:00—in 4.0—out 2.0.—Fast. Size 1. Flight like a shot. Total 1.

9:00 to 9:15—in 3.0—out 2.0.—Fast. Size 2. Out of focus.
Total I.

9:15 to 9:30—in 3.0—out 1.0.—Fast. Size 2.
in 4.0—out 1.0.—Rather slow. Size 2. Wing-
strokes seen.
in 4.0—out 2.0.—Fast. Size 2.
in 2.7—out 4.2.—Slow. Size 3. Wing-strokes
seen. Total 4.

9:30 to 9:45—in 4.0—out 2.0—Fast. Size 1.
in 3.0—out 1.0—Slow. Size 2-|-.

	in 2.0—out 1.0.—Medium slow. Size 3.
	in 3.0—out 1.0.—Fast. Size 2-|- Wing-strokes seen.
	in 2.0—out 4.0.—Fast. Size 2-|- Total 5.
9:45 to 10:00—	in 3.0—out 1.0.—Fast. Size 1.
	in 4.2—out 4.8.—Fast. Size 2.
	in 1.1—out 2.1.—Slow. Size 1.
	in 3.6—out 2.2.—Slow. Size 1. This and all preceding out of focus. Total 4.
10:00 to 10:15—	in 3.5—out 1.5.—Fast. Size 1.
	in 3.5—out 2.5.—Fast. Size 1.
	in 4.3—out 2.6.—Fast. Size 1.
	in 4.3—out 2.6.—Fast. Size 1.
	in 2.9—out 2.2.—Fast. Size 1.
	in 3.5—out 2.5.—Fast. Size 1.
	in 3.0—out 4.1.—Fast. Size 1.
	in 3.0—out 1.0.—Fast. Size 1.
	in 3.0—out 1.0.—Fast. Size 1.
	in 4.1—out 1.0.—Fast. Size 1.
	in 3.0—out 2.1.—Fast. Size 1.
	in 3.5—out 4.7.—Fast. Size 1.
	in 3.5—out 1.5.—Fast. Size 1.
	in 3.7—out 1.7.—Fast. Size 1.
	in 3.0—out 1.0.—Fast. Size 1. This and all preceding out of focus. Total 15.
10:15 to 10:30—	in 4.0—out 4.5.—Fast. Size 1. Out of focus.
	in 3.9—out 1.1.—Size 1. Out of focus.
	in 3.7—out 1.3.—Size 2. Wing-strokes seen.
	in 3.2—out 1.9.—Size 1. Out of focus.
	in 3.7—out 1.9.—Size 1. Out of focus.
	in 3.0—out 1.2.—Fast. Size 2.
	in 3.5—out 2.7.—Fast. Size 1. Wing-strokes seen.
	in 3.7—out 1.9.—Medium. Wing-strokes seen.
	in 2.9—out 1.2.—Fast. Size 2. Out of focus.
	in 3.7—out 1.5.—Fast. Size 1.
	in 2.1—out 1.1.—Fast. Size 2.
	in 2.1—out 4.5.—Fast. Size 2. Out of focus.
	Total 12.
10:30 to 10:45—	in 2.2—out 4.9.—Fast. Size 2. Wing-strokes seen.

	in 4.6—out 3.1.—Slow. Size 2. Wing-strokes seen.
	in 4.4—out —.Slow. Size 1. Out of focus.
	in 3.0—out —.Slow. Size 1. Out of focus.
	in 2.5—out 4.5.—Very fast. Size 1. Out of focus.
	in 2.2—out 4.8.—Fast. Size 1. Out of focus.
	in 2.7—out 4.1.—Fast. Size 2—|—.
	in 2.9—out 4.3.—Fast. Size 2—|—.
10:45 to 11:00	in 2.6—out 1.3.—Fast. Size 1. Out of focus.
	in 3.5—out 1.3.—Fast. Size 2. Wing-strokes seen.
	in 3.1—out 3.9.—Fast. Size 2. Out of focus.
	in 2.2—out 4.3.—Fast. Size 2—|—.
	in 1.9—out 4.8.—Fast. Size 2—|—.
	in 2.7—out 4.8.—Fast. Size 2. Out of focus.
	in 3.5—out 1.3.—Fast. 2—|—.
	in 2.2—out 4.7.—Fast. Size 2. Out of focus.
	in 1.9—out 4.8.—Fast. Size 2.
	in 3.9—out 1.3.—Fast. Size 1—|—.
	in 2.5—out 4.5.—Fast. Size 2. Out of focus.
	in 2.2—out 4.1.—Fast. Size 2. Wing-strokes seen.
	in 2.3—out 1.2.—Fast. Size 2. Total 13.

LAKE FOREST, Ill., May 14, 1900.

METEOROLOGICAL DATA.

Wind—Moderate Southwest.

Temperature—Warm.

Atmosphere—Partly cloudy; showed at midnight.

Total number of birds observed from 9:30 P. M. to 10:55 P. M.—61.

9:30 to 10:00	in 3.6—out 2.9.—Fast. Size 2. Wing-strokes seen.
	in 4.6—out 3.6.—Fast. Size 2. Out of focus.
	in 3.3—out 4.4.—Fast. Size 2. Out of focus.
	in 3.9—out 2.1.—Fast. Size 2—|—.
	in 3.9—out 2.8.—Size 1. Out of focus; like a shot.
	in 4.6—out 2.7.—Fast. Size 1—|—.
	in 4.9—out 1.7.—Fast. Size 2.

in 3.8—out 2.7.—Fast. Size 3. Crow(?).
Wing-strokes plain.

in 4.3—out 2.6.—Fast. 2-|-.

in 4.9—out 1.9.—Fast. Size 2-|-.

in 4.5—out 1.7.—Fast. Size 2.

in 4.3—out 2.4.—Fast. Size 2.

in 4.3—out 2.6.—Fast. Size 2-|-.

in 2.9—out —.—Fast. Size 1-|-.

in 3.8—out 1.2.—Fast. Size 2-|-.

in 4.2—out 3.3.—Fast. Size 2. All the above
in good focus.

in 3.2—out 1.6.—Fast. 2-|- Out of focus.

Total 17.

10:00 to 10:30—in 3.2—out 2.9.—Medium. Size 2. Out of
focus.

in 3.7—out 4.7.—Fast. Size 2-|-.

in 3.3—out 2.6.—Fast. Size 2-|- Out of focus.

in 3.5—out 1.4.—Fast. Size 2.

in 2.6—out 4.4.—Fast. 3—.

in 2.5—out 4.5.—Slow. Size 3. Crow(?).

in 2.5—out 1.9.—Fast. Out of focus.

in 3.5—out 2.5.—Fast. Size 2. Out of focus.

in 2.5—out 2.0.—Fast. Size 2. Out of focus.

in 1.5—out 3.5.—Fast. Size 3—. Wing-strokes
plain.

in 2.9—out 2.2.—Fast. Size 1. Out of focus.

in 4.7—out 1.4.—Fast. Size 1.

in 3.8—out 2.5.—Slow. Size 3.—Crow (?)

Wing-strokes plain.

in 2.9—out 2.3.—Fast. Size 2—.

in 4.6—out 2.4.—Size 1. Like a shot.

in 3.8—out 2.8.—Slow. Size 3. Crow(?).

Wing-strokes plain.

in 3.9—out 2.6.—Slow. Size 2. Wing-strokes
plain.

in 4.4—out 2.6.—Fast. Size 2—. Wing-
strokes dimly seen.

in 1.1—out 1.9.—Fast. Size 1-|-.

in 3.9—out 2.6.—Size 2.

in 3.4—out 2.8.—Slow. Size 3. Wing-strokes
seen.

in 3.8—out 2.8.—Fast. Size 2-|. Wing-strokes
seen.

in 4.8—out 1.4.—Size 2.
 in 4.6—out 2.6.—Size 1-|-.
 in 3.7—out 2.6.—Size 2.
 in 4.1—out 1.4.—Size 3. Total 26.
 10:30 to 10:55—in 3.7—out 2.2.—Medium. Size 3.
 in 4.7—out 2.4.—Fast. Size 1-|-.
 in 3.9—out 1.4.—Medium. Size 2-|- . Appeared
 to be near.
 in 4.7—out 2.3.—Slow. Size 2. Appeared far
 off.
 in 4.3—out 3.1.—Fast. Size 2. Out of focus.
 in 3.6—out 2.6.—Slow. Size 2-|- . Dimly seen.
 in 4.1—out 1.5.—Fast. Size 2-|- .
 in 3.9—out 4.6.—Fast. Size 2-|- .
 in 4.5—out 2.5. Size 1-|- . Like a shot.
 in 3.3—out 1.5.—Slow. Size 2-|- .
 in 4.3—out 2.5.—Slow. Size 2-|- .
 in 1.4—out 3.3.—Slow. Size 2. Dimly seen.
 in 4.9—out 1.6.—Fast. Size 1. Dimly seen.
 in 4.8—out 3.7.—Fast. Size 1-|- . Indistinct.
 in 3.7—out 2.8.—Slow. Size 3. Wing-strokes
 plain.
 in 3.9—out 3.2.—Fast. Size 1-|- . Apparently
 close by.
 in 4.9—out 2.2.—Size 2.
 in 4.5—out 1.5.—Size 2. Wing-strokes plain.
 Total 18.

DETROIT, Mich., May 13, 1900.

METEOROLOGICAL DATA.

Wind—Very light Southwest.

Temperature—70° at 8:00 P. M.—66° at 12:00.

Atmosphere—Fair.

Total number of birds observed from 8:00 P. M. to 12:00 P. M.—111.

[illegible]

- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size, small. Goldfinch (?). Total 8.
- 8.30 to 8:45—in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Moderate. Size, small.
 in $3\frac{3}{4}$ —out $1\frac{1}{4}$.—Moderate. Size, small.
 in 3.0—out $1\frac{1}{2}$.
 in $3\frac{1}{2}$ —out 2.0.—Slowly. Hawk. Flight like hawk or owl.
- in 3.0—out 2.0.
 in $3\frac{3}{4}$ —out $1\frac{1}{2}$.—Rapid. Size, small.
 in $3\frac{3}{4}$ —out 2.0.—Rapid. Size, medium. Total 7.
- 8:45 to 9:00—in 4.0—out $1\frac{3}{4}$.—Size 1.
 in $3\frac{1}{2}$ —out 1.0.—Size 2.
 in $3\frac{1}{2}$ —out $2\frac{1}{4}$.—Size 1.
 in 3.0—out $1\frac{1}{2}$.—Size 2.
 in 3.0—out $1\frac{1}{2}$.—Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{4}$.—Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Size 1.
 in $3\frac{1}{2}$ —out 2.0.—Size 3. All the above at a fast speed. Total 10.
- 9:00 to 9:15—in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Slow. Size 3. Curved above center, changing course at right angles.
- in 3.0—out 2.0.—Medium. Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Slowly. Size 3. Wings spread.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Medium. Size 2.
 in 3.0—out $1\frac{1}{2}$.—Rapidly. Size 1.
 in $3\frac{3}{4}$ —out $1\frac{1}{4}$.—Slowly. Size 3-|. Wing motion seen plainly.
- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1. Total 8.
- 9:15 to 9:30—in 3.0—out 2.0.—Rapid. Size 1.
 in 3.0—out $1\frac{1}{2}$.—Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Size 1.
 in 3.0—out $1\frac{1}{4}$.—Slowly. Size 1.
 in 3.0—out 2.0.—Moderate. Size 1.
 in 3.0—out 2.0.—Slowly. Size 1.—
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 2.
 in 3.0—out $1\frac{1}{2}$.—Moderate. Size 2.
 in $3\frac{1}{4}$ —out $1\frac{1}{2}$.—Size 2. Very rapid flier. Total 9.

- 9:30 to 9:45—in 3.0—out 2.0.—Moderate. Size 2.
 in 3.0—out 2.0.—Moderate. Size 2.
 in $3\frac{3}{4}$ —out $1\frac{3}{4}$.—Rapidly. Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Slowly. Size 3—|. Duck or
 loon, neck stretched out.
 in $3\frac{1}{2}$ —out $1\frac{3}{4}$.—Rapidly.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.
 in $2\frac{1}{2}$ —out $1\frac{1}{2}$.
 in $3\frac{1}{2}$ —out $4\frac{1}{2}$.—Slowly. Size large. Note di-
 rection.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapidly. Size 3. Total 10.
- 9:45 to 10:00—in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Size 2. Appeared to be two
 birds together.
 in 3.0—out 1.0.—Size 1—.
 in $3\frac{3}{4}$ —out $1\frac{3}{4}$.—Slow. Size 3.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1—.
 in 3.0—out 1.0.—Size 2.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Size 3.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Size 2.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Size 1. Goldfinch motion.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Very fast. Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 2.
 in 3.0—out 1.0.—Size 2.
 in $3\frac{1}{2}$ —out 1.0.—Very fast. Size 1. Curved
 upwards to 1.
 in 3.0—out $1\frac{1}{4}$.—Very fast. Size 3. Total 14.
- 10:00 to 10:15—in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Moderate. Size 1.
 in $3\frac{3}{4}$ —out $1\frac{1}{4}$.—Size 1.
 in 4.0—out 1.0.—Rapid. Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Very slow. Size 2. Wing
 motions plainly seen.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1.
 in 4.0—out 1.0.—Rapid. Size 1. Total 8.
- 10:15 to 10:30—in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1.
 in 4.0—out 1.0.—Size 1.
 in $3\frac{1}{2}$ —out $1\frac{1}{4}$.—Size 1.
 in $3\frac{3}{4}$ —out $1\frac{3}{4}$.—Slowly. Size 2.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Moderate. Size 3.
 in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Moderate. Size 3.

- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1. 2 in rapid succession.
- in $3\frac{1}{4}$ —out $1\frac{3}{4}$.—Rapid. Size 1.
- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1. Total 9.
- 10:30 to 10:45—in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Moderate. Size 2.
- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1.
- in $3\frac{1}{2}$ —out 2.0—Moderate. Size 3.
- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Very fast. Size 1.
- in $3\frac{1}{2}$ —out $\frac{1}{2}$.—Very fast. Size 1-|-.
- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Moderate. Size 2. Total 6.
- 10:45 to 11:00—in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Moderate. Size 1.
- in $3\frac{1}{2}$ —out 2.0.—Very fast. Size 1.
- in $3\frac{3}{4}$ —out $1\frac{3}{4}$.—Rapid. Size 1.
- in $3\frac{1}{4}$ —out $1\frac{1}{4}$.—Very slow. Size 1. Wing motion seen. Took three seconds to cross the field. Total 4.
- 11:00 to 11:15—in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Fast. Size 1.
- in $3\frac{1}{2}$ —out 2.0—Slow. Size 3.
- in $4\frac{1}{4}$ —out $2\frac{3}{4}$.—Slow. Size 3. Note direction.
- in $3\frac{1}{2}$ —out $2\frac{1}{4}$.—Rapid. Size 1.
- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 1.
- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 2.
- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 2. Total 7.
- 11:15 to 11:30—in $3\frac{1}{2}$ —out $4\frac{1}{2}$.—Rapid. Size 2.
- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Moderate. Size 1.
- in $3\frac{1}{2}$ —out 2.0.—Moderate. Size 2. Curved over center.
- in $3\frac{1}{2}$ —out $1\frac{1}{2}$.—Rapid. Size 2. Total 4.
- 11:30 to 11:45—in $2\frac{1}{4}$ —out $4\frac{3}{4}$.—Rapid. Size 2. Time, 11:32. Total 1.

EXPLANATION OF PLATES.*

Plate I.

Curves drawn from observations collected by means of the telescope at Ann Arbor, Mich., Detroit, Mich., Lake Forest, Ill., and Beloit, Wis. These curves show the number of birds flying in periods of fifteen minutes.

Plate II.

Same as plate I. for Madison, Wis., with the exception that the curves have in each instance been reduced to the same number of hours after moon-rise.

Plate III.

A combined curve of three successive observations taken at Madison, Sept. 11, 12 and 13, 1897. The curve has again been reduced to hours after moon-rise. This combined curve brings out more strikingly the general conditions observed at Madison with reference to the influence of topography upon the number of birds flying.

Plates IV. and V.

In plates IV. and V. each circle represents the field of observation as seen through the telescope when focused on the moon. Each line in the circle represents the flight of one bird, the heavily shaded end showing the direction toward which the bird is flying. The broken lines represent the flight of birds that appeared out of focus. The data from which these two plates were made were taken at Beloit, May 12, 1900.

Plates VI. and VII.

Same as plates IV. and V. for Beloit, May 11, 1900.

Plate VIII.

Same as plates IV. to VII. from data collected at Madison at various times from April 8, 1898, to May 9, 1900. The arrows outside of the circle show the approximate direction for the period. It is to be noted that there are two main directions followed, the one predominating in April, the other in May.

*For a clear understanding of the plates it will be necessary to keep the method of observation in mind. See pages 198 to 199 in text.

Plate I.

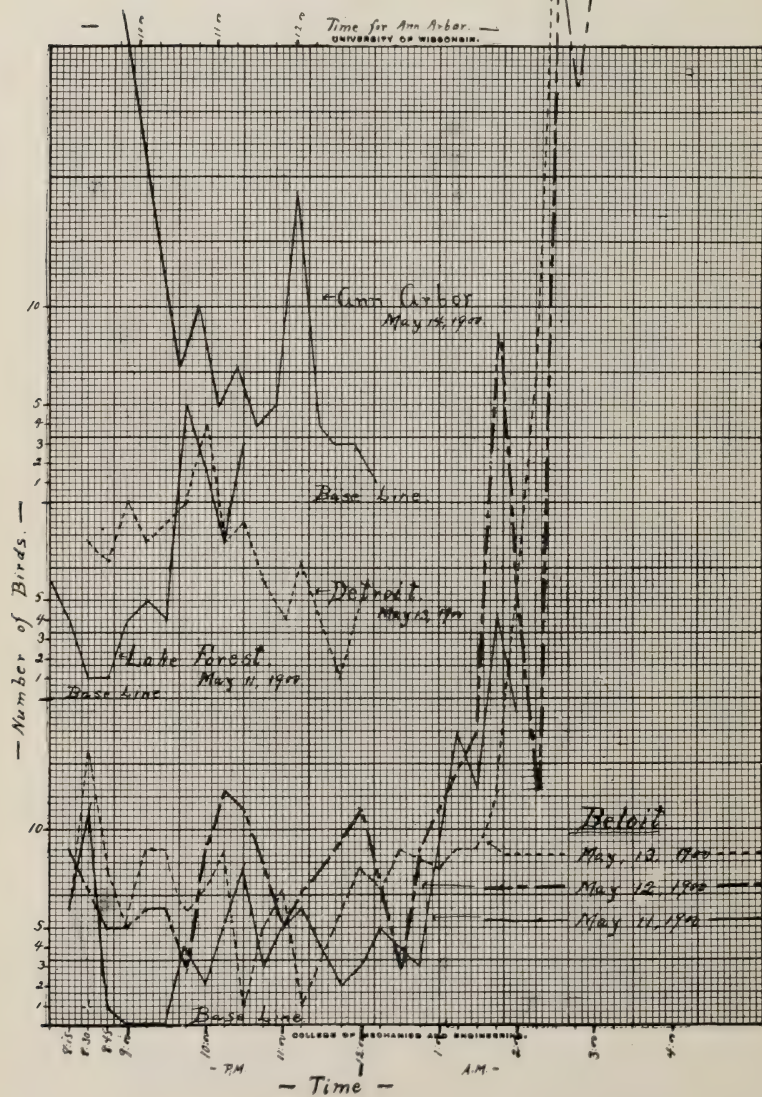


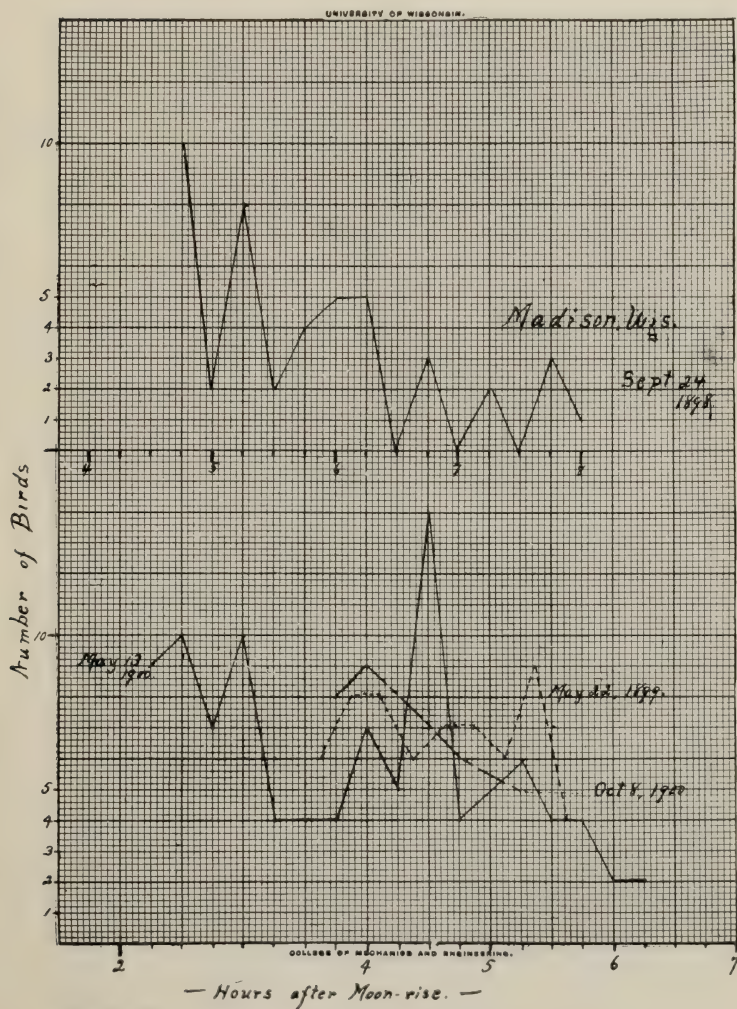
Plate II.

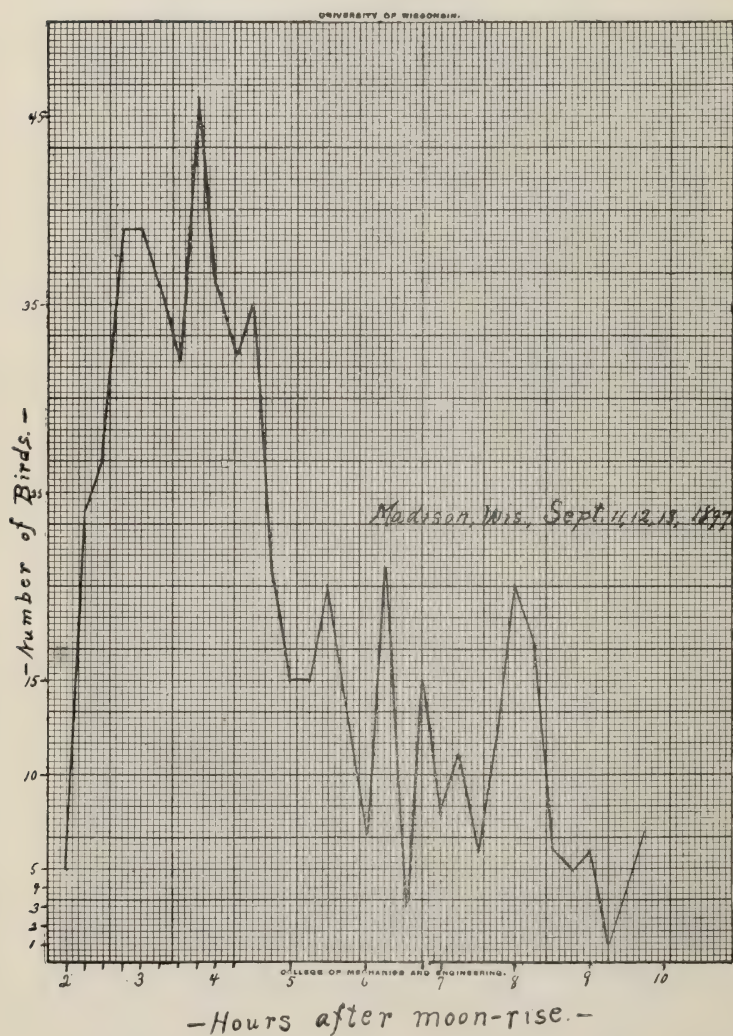
Plate III.

Plate IV.

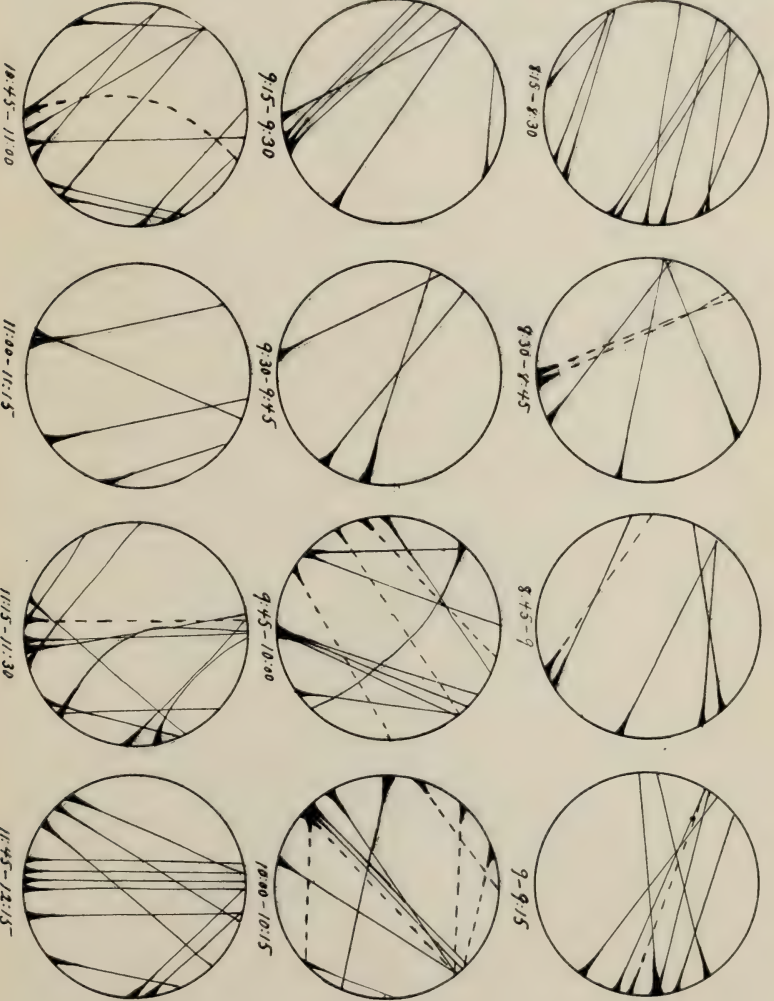


Plate V.

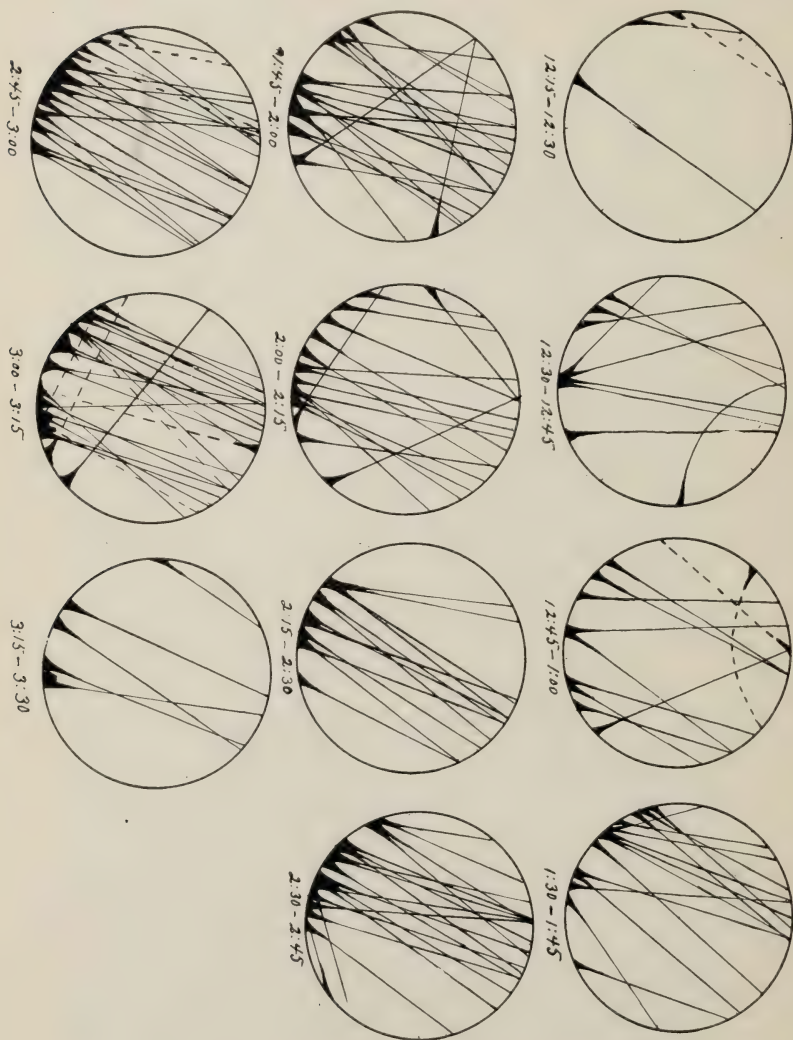


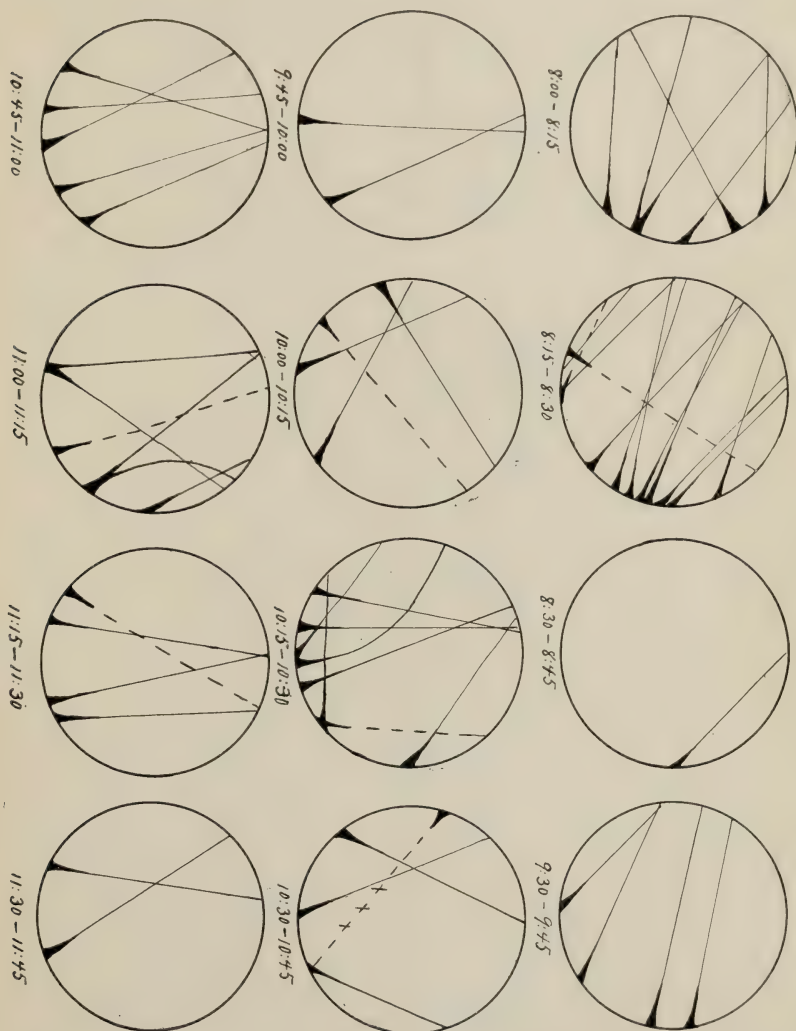
Plate VII.

Plate VII.

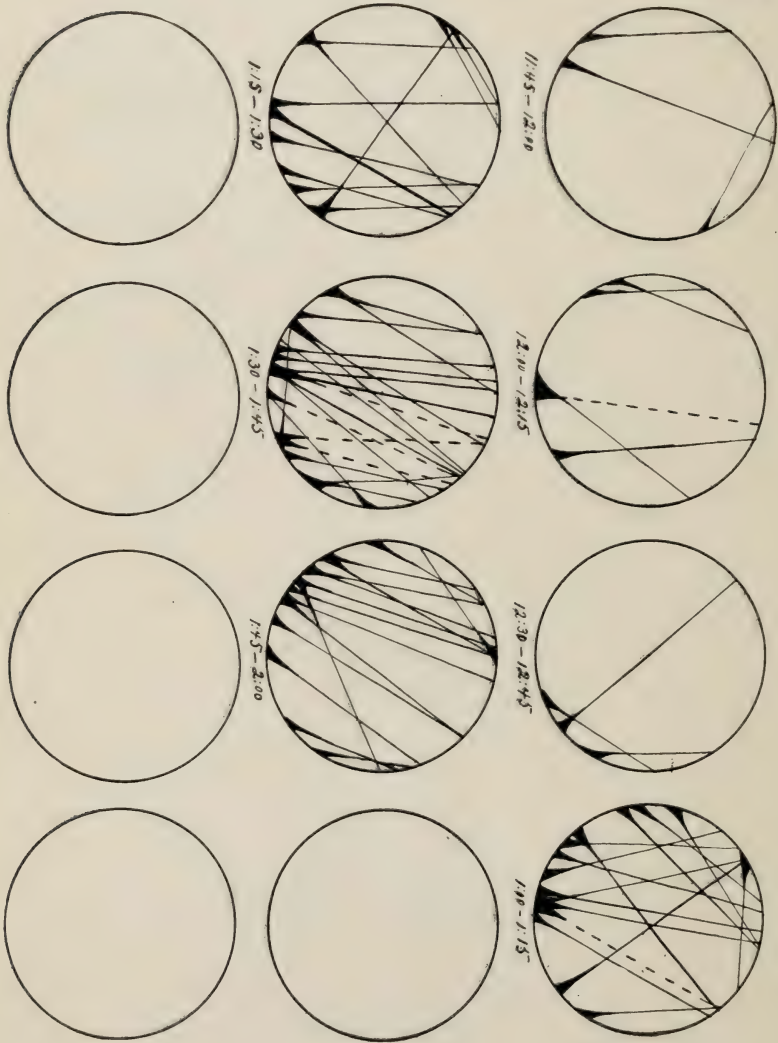


Plate VIII.

